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ANNUAL REPORT

OF THE

CHIEF OF ORDNANCE

TO THE

SECRETARY OF WAR

FOR THE

FISCAL YEAR ENDED JUNE 30, 1896.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1897.

REPORT OF THE CHIEF OF ORDNANCE.

WAR DEPARTMENT, ORDNANCE OFFICE,
Washington, October 1, 1896.

SIR: I have the honor to submit the following report of the principal operations of the Ordnance Department during the fiscal year ended June 30, 1896, with such remarks and recommendations as the interests of this branch of the military service seem to require.

The fiscal resources and expenditures of the Department during the year were as follows, viz:

Amount in the Treasury to the credit of the appropriations on June 30, 1895	$2,868,744.16
Amount in the Treasury not reported to the credit of the appropriations on June 30, 1895	795.27
Amount in Government depositories to the credit of disbursing officers and others on June 30, 1895	414,515.54
Amount of appropriations for the service of the fiscal year ended June 30, 1896	2,780,739.02
Amounts refunded to ordnance appropriations in settling accounts during the fiscal year ended June 30, 1896	13,840.67
Gross amount received during the fiscal year ended June 30, 1896, from sales to officers; from rents; from collections from troops on account of losses of or damage to ordnance stores; from Chicago, Rock Island and Pacific Railroad Company; from powder and projectiles (proceeds of sales); from sales of condemned stores; from testing machine, and from all other sources not before mentioned	262,360.19
Total	6,340,994.85
Amount of expenditures during the fiscal year ended June 30, 1896, including expenses attending sales of condemned stores, exchange of powder, etc	4,089,931.42
Amount deposited in Treasury during the fiscal year ended June 30, 1896, as proceeds of sales of Government property	9,799.22
Amount turned into the surplus fund on June 30, 1896	11,499.65
Amount in Government depositories to the credit of disbursing officers and others on June 30, 1896	425,003.77
Amount transferred from ordnance appropriations in settling accounts during the fiscal year ended June 30, 1896	13,916.51
Amount in the Treasury not reported to the credit of appropriations on June 30, 1896	747.42
Amount in the Treasury to the credit of appropriations on June 30, 1896	1,790,096.86
Total	6,340,994.85

ARMING AND EQUIPPING THE MILITIA OF THE UNITED STATES.

The requisitions from the different States for ordnance and ordnance stores have been filled during the year to the extent which the limited appropriation for arming and equipping the militia would permit. The insufficiency of this appropriation for completely arming and equipping the militia has been shown by urgent applications for stores which could not be supplied under the appropriation. This is a repetition of the experience of former years, and attention has been invited to it in previous reports.

Three recommendations were submitted to the Secretary of War in my annual report of last year, for action by Congress, to improve the armament and equipment of the militia without increase of the appropriation for this purpose. These recommendations were approved and submitted to Congress. The first was as follows:

> *Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That hereafter when any State, Territory, or the District of Columbia turns in to the War Department arms, equipments, or other military supplies, under instructions from the Secretary of War, obsolete or unserviceable, which have been issued by said Department under the law for arming and equipping the militia, the Secretary of War will cause the value of such old and unserviceable or obsolete material turned in to be determined, and will report its value from time to time to the Secretary of the Treasury, who is directed to then credit to the appropriation for arming and equipping the militia the amounts so reported to him by the Secretary of War; and the necessary amount is hereby appropriated for the purpose. The Secretary of War, on receiving notification from the Secretary of the Treasury that the amounts have been carried to the appropriation aforesaid, will credit the respective States, Territories, or District, as the case may be, with the amounts to which each shall be entitled.

I respectfully invite your attention to the statement made in my last annual report of the advantages which would accrue from this law. It would give to the militia some valuable service-pattern supplies in exchange for practically useless material now in the possession of the States, and it is desirable that the possibility that State troops might some time be called into actual service armed and equipped with such obsolete and practically useless supplies should be avoided. It is not known that Congress took any action in regard to this recommendation other than the introduction of a bill (H. R. 2781) containing this provision in the House and its reference to the Committee on Military Affairs, though it is believed that this provision was contained in some of the comprehensive militia bills which were introduced and not passed.

As the recommendation is still before Congress, it is hoped that action thereon may be taken at its next session.

The other two recommendations are contained in the following bill, which was introduced in both Houses, and passed by the Senate March

18, 1896, and which is now before the House Military Committee, and which did not pass the House. The bill is as follows:

A BILL authorizing the Secretary of War to issue Springfield rifles to each State and Territory for the National Guards thereof, in exchange for other rifles now held.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of War is hereby authorized to issue to the governors of the several States and Territories such number of Springfield breech-loading rifles, caliber forty-five one-hundredths of an inch, as are now required for arming all of the regularly organized, armed, and equipped militia (generally known as the National Guard) of each State and Territory that are not already supplied with this arm: *Provided,* That each State or Territory be required on receipt of the new arms to turn into the Ordnance Department, United States Army (without receiving any money credit therefor), all the arms now in its possession, except its Springfield rifles, caliber forty-five one-hundredths of an inch.

SEC. 2. That each State and Territory shall hereafter make an annual return to the Secretary of War of all the arms issued to them under this or any former act of Congress as provided for in the act of February, eighteen hundred and eighty-seven, making a permanent annual appropriation for arming and equipping the militia.

SEC. 3. That any State or Territory may, in addition to the stores and supplies issued under the provisions of this act and the act of February, eighteen hundred and eighty-seven, purchase for the use of its National Guard or Reserve Militia, at regulation prices for cash at place of sale, such stores and supplies from any department of the Army as, in the opinion of the Secretary of War, can be spared.

I respectfully invite your attention to the recommendations in my last annual report for the enactment of the provisions contained in sections 1 and 2 of the above bill. The very great importance of these provisions for the efficiency of our National Guard is now so well known to the National Guard and to Congress that it is reasonable to suppose this law will be passed by Congress at its next session.

While section 3 is relatively of less value, it is nevertheless very important, and would be of great advantage to the State troops, and no objection to its enactment is known.

Regulations now require that the stores supplied to States under the law for arming and equipping the militia shall conform to the armament and equipment of the Regular Army. It is well known that the limited appropriation is sufficient to supply only a small portion of the arms and equipments required by some of the States, and that the remainder is obtained with appropriations made by the States themselves. The States desire that these supplies obtained with their own appropriations should be the same as those furnished by the General Government and those used by the Regular Army, and it is of the utmost importance for military reasons that they should be the same. It is unreasonable, therefore, that the General Government should refuse to sell such supplies, and yet there is no law to permit it. The result is that the States are not generally able to procure uniform arms and equipments with their own appropriations, although this Department has uniformly done all in its power to aid them in accomplishing this by furnishing patterns and drawings and specifications for manufacture. There should be added to this section 3 a clause to provide for crediting the proceeds of such sales to the appropriations to which they belong, in order to permit the departments to which they belong to replace therewith the supplies sold.

ROCK ISLAND ARSENAL.

The work to be carried on in the various departments at the arsenal included the completion of fifty 3.2-inch field-gun carriages, with their limbers complete, twenty 5-inch siege-gun carriages, and twelve 7-inch howitzer carriages.

The receipts at this post from the Army, with smaller lots from the militia and sundry persons, consisted of 780 lots, weighing about 550,000 pounds, and the issue principally to the Army amounted to 1,894 lots, aggregating in weight 1,300,000 pounds.

The water-supply system at the arsenal has been increased by enlarging the pump house capacity and putting in practically new boilers, while the boiler plant at Shop C has been renewed by the addition of two water-tube Webber boilers having a capacity of about 200 horsepower each.

Additions have been made to the machinery plant of three engine lathes and two drilling machines, while the machine for turning the side bars of saddletrees is partially completed.

The improvements of the dikes about the island and water-power system have been completed, except a part pertaining to the Moline water-power dam wall, on which work is progressing.

The erection of the new superstructure of the Rock Island Railroad bridge and the alteration of masonry piers and abutments have been in progress, and it is expected that they will be completed, so far as the resumption of traffic over the bridge is concerned, about the 1st of December next, and entirely completed about one month later.

The attention of the Secretary of War and of Congress has been frequently invited to the fact that modern field and siege artillery differs so completely from and is so vastly superior in power, accuracy, and rapidity of fire to the artillery of these classes used in our civil war that this old artillery would be nearly useless in any future war. In fact, the siege artillery has already been condemned and practically disposed of, and there is none of it on hand.

All the types of guns and carriages for this new field and siege artillery have been completed, manufactured, tested, and adopted (except that some modifications and improvements are still in progress); our few light batteries have been equipped with the new field guns and material, and some of these have also been issued to State troops. A large number of field guns and carriages are still called for by and required for State troops; but it is most important that we should have a reserve of both field and siege artillery for issue in case of any emergency which might require the use of land troops. The importance of this can not be overstated.

The discussion of this subject with committees of Congress, and the action of such committees at the last session of Congress, show that the necessity for providing this artillery was appreciated.

The arsenal designed for the manufacture of the carriages, implements, and equipments, and harness for both field and siege artillery, is the Rock Island Arsenal. It is the one that is best suited for this work. All of these carriages are of steel and are of new types, and the requirements admit of only the highest excellence in the character of work that it is possible to obtain. No special appropriation for the plant for these manufactures has been made, and the only provision is that of the machine shop, forging shop, and foundry, which were fitted up with the plant necessary for the economical erection of the arsenal, and the addition of a few machines of special importance that could be added with funds available for the work from time to time. This provision is not the very best for convenient and economical work, and even when crowded unduly its utmost limit of capacity is the production of about 50 field steel carriages and limbers, 50 caissons and limbers, 8 combined battery wagons and forges, and 20 siege carriages and limbers per annum.

The arsenal shop specially designed for the manufacture of these carriages is the shop east of and adjacent to the forging shop (known as Shop G). It is proposed to install power, heating, and lighting in this shop, and at the present time enough machines to rather more than double the capacity or output per annum, and to arrange for more economical and convenient work. The plans embrace also the installation in the adjacent wing of the forging shop (Shop E) the necessary increase of forging plant, which constitutes a large and important part of this work. An estimate of $75,875 for this purpose is included in my annual estimates for this year, and, as is indicated by what has been stated, the introduction of this plant is deemed of the utmost importance to our military establishment.

The plans contemplate the ultimate addition to this plant of all the machines that the Shop G mentioned can accommodate, for use in times of emergency, and it is believed that the shop has sufficient capacity when so utilized, in connection with such work as could still be performed in the general machine shop, to make the annual output about 240 field carriages, 360 caissons, 40 combined battery wagons and forges, 30 traveling carriages and limbers for the 5-inch siege gun, 30 carriages and limbers for the 7-inch siege howitzer, and 30 carriages for the 7-inch siege mortar per annum.

WATERVLIET ARSENAL.

SEACOAST GUN FACTORY.

Owing to the insufficiency of available funds for finishing and assembling guns, work at the Army Gun Factory has been retarded during the past year and a number of the employees have been discharged. By April and May last the gun shop was running at only about half its full capacity. Of the sum of $443,458, submitted by the Department in its annual estimates for 1896 for finishing and assembling guns, Congress appropriated only $225,000, or about one-half the sum needed to keep the shop running at its full capacity. However, the output at the Gun Factory during the past year has been as follows: Ten 8-inch, nine 10-inch, and nine 12-inch guns completely assembled, and in addition a number of guns advanced toward completion, making a total equivalent of about thirteen and a half 8-inch, thirteen and one-third 10-inch, and ten and three-quarters 12-inch guns.[1] In addition to these heavy guns there have been completed ten 5-inch siege rifles, ten 7-inch siege howitzers, and ten 3.6-inch field mortars; also six 7-inch siege mortars have been nearly completed; three 3.2-inch rifles have been converted to rapid-fire guns by relining and fitting with the Dashiell, Fletcher, and Seabury breech mechanisms, respectively. A Gerdom 3.2-inch rapid-fire gun has also been manufactured. Considerable other work in the nature of alterations and repairs has been accomplished during the year.

The equipment of the south wing for the manufacture of 16-inch guns will be finished before the expiration of the present calendar year, all of the machinery having now been delivered and erected. The back-rest bearings and boring-bar rest bearings for the four 16-inch gun lathes are now being finished, bored, and turned in place. Work on the shafting and belting of these lathes is nearing completion. Throughout this plant the necessary number of friction clutches has been provided, so that the whole or any part of it may be thrown out of connection if desired. The interior cylinder of the jacket-heating furnace has recently been replaced by a new one, after being subjected to a continuous service for about five years. Designs and estimates have been prepared for a new heating furnace for shrinkage purposes, to be operated by means of oil gas. This furnace will be of such proportions as to admit of heating and handling the largest forgings for 16-inch guns, and promises good results. An estimate for its construction is included in the annual estimates submitted by the Department. The new skeleton reamer heads referred to in my last annual report have been subjected to trial and proved to be a complete success. All the important gauges and templets required to secure uniformity in the parts of breech mechanism of different guns, and interchangeability of such parts, have been completed.

FIELD AND SIEGE GUN FACTORY.

In addition to the large factory for finishing and assembling seacoast guns, there is at this arsenal an excellent small shop, made by the utilization of a gun-carriage timber shed (one of the buildings of the old establishment) for the manufacture of field and siege guns. It is properly equipped with a heating furnace and shrinkage pit and a few machines sufficient for the manufacture of 50 field guns per annum. The shop has sufficient room for enough additional machines for increasing its capacity to about three times the present capacity. In view of the imperative necessity for providing our military establishments with a limited number of modern field and siege guns for immediate use in case of emergency, I know of nothing in connection with the operations of the Ordnance Department of greater importance than the increase of the capacity of this shop, and an estimate of $48,000 for the purchase of the necessary machines and fixtures for this increase of capacity is submitted in my annual estimate this year.

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[1] The total number of seacoast guns completed at the Gun Factory since the completion of the first wing of the factory and the commencement of work therein, 1891, is forty 8-inch, forty-one 10-inch, and twenty-one 12-inch.

WATER POWER.

The new water-power plant described in my last annual report was finished last autumn, and has since been in successful operation. It became necessary to operate this power plant during the greater part of last winter from the gun shop by means of electricity, in order to run the lower shops and the water-supply pump, as the water was withdrawn from the Erie Canal for a considerable time by the State authorities for the purpose of surveys and repairs. Under such circumstances it is found to be more economical to run the lower shops and the pumping station electrically from the gun shop than to employ the existing independent steam-power plant for this purpose. On two different occasions during the past winter, owing to pressure which caused back water to rise several feet above the basement floor, on which the turbines are located, a complete stoppage of the water power resulted for about a week in each case, during which time the lower shops were run entirely by electricity from the gun shop. These incidents illustrate the wisdom of the provision made originally in installing the electric-light and power plant so as to run one of the generators at the lower station as a motor, with current supplied from the station in the gun shop. The motor capacity of this generator is about 55 horsepower. The requirements were, however, on several occasions considerably in excess of this, especially on account of the increased demand for water supply, so that it became necessary to make arrangements whereby the second generator in the lower station could also be operated as a motor simultaneously with the other. The electric light and power plant after another year's trial has given very gratifying results.

WATER SUPPLY.

The new water tower, with its equipment and the necessary connections, has been completed to the extent of the appropriations, and has been in operation for several months. An independent and satisfactory supply of water for the operation of the shops, and to a limited extent for fire protection, has been thus established. There still remains the necessity for creating a subdivision of the existing water system so as to supply quarters, offices, etc., with pure water suitable for drinking purposes. This can be accomplished by supplementing the system of distributing pipes at the post with a 5-inch main and by procuring a new tank for the water tower to contain doubly filtered water for domestic purposes. The proposed system for fire protection at this post has been inaugurated during the present year, but the sum appropriated was only sufficient to procure a few of the most needed appliances, such as steam fire engine, two hose carts, 1,200 feet of 2½-inch cotton fire hose, and the installation of an electric fire-alarm system. These arrangements will still require for their completion a ladder truck, stationary hose racks in the shops, stationary ladders for access to the roofs of the gun shops, an extension of the distributing main around the south wing of the gun shop, and an increased number of hydrants.

Coal-storage bins have been erected during the past year west of the boiler house of the gun shop. The foundation of the coal bins is of concrete, and the superstructure is a combined construction of iron and wood, insuring great rigidity and endurance, and reducing the cost for maintenance to a minimum. The coal-storage capacity of the gun factory is about 3,000 tons—namely, 1,500 tons in coal-storage bins, and 1,500 tons between and beneath the trestles of the bins.

The condition of the masonry of the sea walls and the culvert at the north end of the Arsenal grounds is such as to urgently require extensive repairs at this time.

WATERTOWN ARSENAL.

SEACOAST GUN-CARRIAGE FACTORY.

The gun-carriage work at this post has progressed satisfactorily during the year, the output being six barbette carriages, f. p. for 15-inch S. B. gun; four barbette carriages for 10-inch B. L. rifle; one barbette carriage for 12-inch B. L. rifle; five disappearing carriages for 8-inch B. L. rifle; one disappearing carriage for 10-inch B. L. rifle; two gun-lift carriages for 12-inch B. L. rifle, all completed. In addition, considerable work has been done on six 12-inch spring-return mortar carriages; six 7-inch siege-mortar carriages and platforms; three 12-inch gun-lift carriages to be altered to nondisappearing barbette carriages; two 15-inch front-pintle carriages altered to new model, and five 10-inch disappearing carriages. Besides this work, a large number of spare parts and implements for carriages, articles for mechanical maneuvers, and several thousand cast-iron projectiles of all calibers have been manufactured. The construction of 12-inch disappearing carriages at this post has necessitated the purchase of a larger planer than any heretofore contemplated, and a contract has been awarded for an iron planer 12 feet by 10 feet by 25 feet, which will be set up in the erecting shop, as the other shops are too narrow for it.

With the increased quantity of work done at this post it is found that the foundry has not the capacity required. Under recent appropriations the facilities for carriage manufacture have been increased by an additional boiler plant and engine. This will give sufficient boiler capacity to run all the engines, supply the steam heating arrangements, and run a 75-horsepower dynamo. It is also contemplated to equip one of the large cranes in the erecting shop now operated by hand power with electric power as soon as the electric plant can be installed.

It is proposed to remove the open blacksmith shop to the cellar of the machine shop, where it will not accumulate dirt, and where the belts will not be so quickly destroyed. A small engine of about 15-horsepower will be all the power then required for the blacksmith shop to run the shears and bolt machine, and these will only run at intervals, not amounting to a month in the whole year. Then, by dispensing with the present wire-rope transmission, a considerable saving in horsepower will be effected.

It is very necessary that proper storage should be provided for the seacoast carriages after their completion and before they are shipped to their final destination. At present the only method available is to place the carriages in the open air, near the arsenal railway track, and to provide expensive and ineffectual protection from the weather with canvas and board covers. This method also involves great expense in unloading and loading the carriages. A building for this purpose was included in the original design for the seacoast gun-carriage factory. There is no building at the arsenal of such construction and capacity as to admit of its utilization for this purpose. It is necessary that it should be adjacent to the setting-up shop and provided with a railway track between it and the setting-up shop, and should also be provided with a crane for the economical handling of the carriages. An estimate for this necessary and important purpose is included in my annual estimate for this year.

With regard to the care to be exercised in the erection of these modern seacoast carriages in their emplacements, the commanding officer of the Watertown Arsenal states in his report as follows:

> With gun carriages of such complicated and nicely adjusted pieces of mechanism great care has to be taken in their erection to have all of the parts work accurately and smoothly together, and this is particularly true of the disappearing carriages. Equally great care should be taken in their transportation and erection in their emplacements. This latter work should not be intrusted to unskilled labor with extemporized implements. The carriages need be erected properly at first by skilled mechanics familiar with the designs of the carriages and accustomed to their erection and adjustment. If such men are not available at the forts, the Department should maintain a force at this arsenal or elsewhere for this purpose; and as the gun platforms are liable to settle under the heavy weights imposed upon them, the carriages should be releveled from time to time until they have assumed a permanent level. I have thought it proper to mention this subject in this connection, for, no matter how good the design or workmanship, defective mounting will not give satisfactory results.

OFFICE, HOSPITAL, AND QUARTERS.

A suitable office and administration building is most urgently demanded at this arsenal. The lack of office facilities and a drafting room has cost vexatious and expensive delays in the work. The present office was built in 1817, and is a small building, containing only four small rooms, adapted to the wants of the small arsenal that was built at that time. The officers, clerks, and drafting department are all crowded into this small space, without proper facilities for performing their duties, and especially it is impossible to make provision for arranging and filing the valuable drawings, so as to admit of their examination and use. The same remark applies to the arsenal records.

The arsenal has no hospital, except a wooden cottage in a distant part of the grounds, so old and dilapidated as to make its further preservation difficult.

The officers' quarters were built as a part of the old establishment at the same time as the office. They are badly situated in connection with the new establishment, are old, and their maintenance is expensive. One of them occupies the most desirable site for the new office. The most desirable plan is to alter and fit up one of these buildings for the new office, to alter and fit up the other for a hospital, and to build two new modern buildings in a suitable situation for officers' quarters. An estimate for this purpose has been included in my annual estimates last year and this year.

TESTING DEPARTMENT.

In addition to the large number of tests made for private parties, the cost of which is paid by the parties for whom the tests are made, "investigation tests" are in progress, having in view the improvement of many important materials used in engineering, architecture, and mechanical constructions. There has also been much important work done in this department during the year which applies directly to the constructions of the Ordnance Department, especially in connection with seacoast gun and carriage construction.

Some of the more important of these include tests of specimens from forgings for cannon, specimens from receivers for small arms, specimens of cast iron from the arsenal foundry for metal to be used in shot and shell and gun carriages, of pig iron purchased, or samples on which bids for supplies are received; of the bronze composition used for loading trays, breech plates, etc., for cannon, and steel samples representing the material for the Rock Island bridge. Helical springs for gun and mortar carriages have been examined and proved, and proof stresses have been applied to piston rods, suspension rods, etc., for gun carriages. Experiments have also been made to determine the resistance of banded shot and shell through the bore of guns of different caliber. These experiments have included the 3.2-inch field gun, 5-inch siege rifle, 7-inch howitzer, and 8-inch and 10-inch seacoast guns. As the condition of the surface of the bore exerts a considerable influence on the frictional resistance of the band of a projectile, in these experiments observations were made with gun intentionally fouled by firing three rounds with blank cartridges, and an enormous increase in frictional resistance was ascertained to be the result. With bands of modified form and dimensions, the place at which the maximum resistance was attained was different from that with the ordinary type of band. The rate of speed of the projectiles was necessarily a low one, but taken over such limits as the testing machine permitted, it was found that the frictional resistance increased with the speed. Much valuable information has also been obtained with regard to the initial compression of copper cylinders, for use with the pressure gauges employed for cannon, the object being to approximate more nearly than by the ordinary operation of the testing machine the rapid application of pressure that actually occurs in the gun. The results have confirmed what had already appeared in the testing machine, that the total compression set of a copper cylinder depends much upon the interval of time of compression; the shorter the time, the less the total set to the cylinder. These results were most pronounced in examples with uncompressed coppers and with cylinders intended for the small-arms pressure gauges, from which it would appear that lower indicated powder pressures should be expected from uncompressed coppers than from those initially compressed before firing; and this deduction is confirmed by experience at the Proving Ground.

SPRINGFIELD ARMORY.

The manufacture of new arms during the year ended June 30, 1896, comprised 10,535 magazine rifles, 7,111 magazine carbines, and 404 cadet rifles, caliber .30; and 1,800 Springfield rifles, caliber .45, were altered to cadet rifles, model 1884. The daily output of the armory is now 120 magazine rifles or carbines, and as they are to be made in the proportion of 5 to 1, the shops will be run on carbines during two months in each fiscal year. The buildings used as shops are not occupied with machinery to their full capacity. With the machines and tools now in use 125 arms can be turned out in a day of eight hours. The buildings now occupied can be arranged to produce 200 arms per day, and additional estimates have been prepared, by using other available buildings, to produce 300 or 320 arms per day, and on the last basis, by working two gangs ten hours each, to produce 500 arms per day of twenty-four hours. The changes made last year in the operations for the manufacture of the different parts of the magazine arm have given satisfactory results, and the new methods have been extended.

The standing instructions to the commanding officer of the armory to examine and report upon new inventions in magazine small arms which may be presented have not resulted in any developments during the year.

Under appropriations made, Federal street, owned by the United States, has been macadamized about two-thirds of the length, and estimates are submitted for funds to complete it, and also to macadamize the portion of Byers street that is owned by the Government. These streets are used as highways in the city of Springfield, and are too extensive to be kept in order from the usual annual allotments for buildings and grounds, and as the city improves its streets, attention is demanded to those owned by the Government.

One of the two new sets of quarters for officers remains uncompleted by reason of lack of available funds. The two sets of quarters for noncommissioned officers referred to in the last annual report have been fitted up and occupied; the old frame building in rear of the hospital has been removed, and the small set of brick quarters near this last has also been moved and placed in line with the brick set moved the previous year.

FRANKFORD ARSENAL.

The resources of this arsenal were fully employed during the past year in the manufacture of small-arm and field-artillery ammunition and other usual products, chiefly cannon primers, sights for cannon, and inspecting instruments. The output of .30-caliber ammunition comprised about 5,067,000 ball and 1,207,000 blank cartridges, showing a considerable increase over the preceding year, but scarcely more than enough for the current needs of the service. During the present year it is expected that a small reserve supply of this ammunition can be accumulated. A number of new and improved machines for cartridge manufacture have been made or purchased, increasing the capacity of the plant and cheapening the processes. At present the product is limited to about 23,000 rounds of .30-caliber ammunition with a proportion of other cartridges (principally for the .45-caliber Springfield rifle and carbine, and the .38 and .45 caliber revolvers) not exceeding 8,000 rounds per diem. By the end of the present fiscal year it is expected to attain a daily output of 50,000 rounds, including blanks for all calibers, and the manufacture of .30-caliber ball cartridges may be increased to 30,000 per diem. A part of the plant is maintained for the manufacture of .45-caliber ammunition to a limited extent yearly, with the object of keeping a reserve on hand for the .45-caliber Springfield rifle and carbine.

The plant for manufacture of field-artillery ammunition has been improved, more particularly with reference to drawn cartridge cases for fixed ammunition in field guns. The output of this plant for the past year has comprised a number of drawn brass cases for the 1.65-inch mountain and 3.2-inch field guns, shell and canister for the mountain gun, canister and shrapnel for the 3.2-inch gun, and shrapnel for the 3.6-inch gun and mortar, besides the combination time and percussion fuses for the shrapnel and a quantity of base or point percussion fuses for shell. Sample 5 and 7 inch shrapnel, to establish patterns for future manufacture, were made at Frankford Arsenal and satisfactorily tested at the Proving Ground. Descriptive reports, with drawings of these shrapnel and of the shrapnel of the 3.2-inch and 3.6-inch caliber, prepared at Frankford Arsenal, are appended.

The chemical laboratory at Frankford Arsenal has been in constant use for the examination and test of smokeless powders received under contracts, and for tests of samples received by the Department. The results, other than those relating to the chemical analysis of powders, which are not published, are given in the appended report of Major Pitman, in charge of the laboratory during the year.

CARTRIDGE FACTORY SHOPS AND SHOPS FOR THE MANUFACTURE OF FIELD AND SIEGE ARTILLERY AMMUNITION.

I most earnestly invite your attention to the obvious and important necessity for increasing the capacity of this arsenal for the manufacture of metallic ammunition for both small-arm and field artillery.

When the manufacture of metallic small-arm ammunition was inaugurated by the United States Ordnance Department at this arsenal in 1864, a suitable and most excellent building for this purpose was commenced, and about completed in 1866. The building still requires some interior finish and the addition of the necessary power, including a chimney stack, a boiler house and plant, and shafting and other shop fixtures. This building has never been utilized.

All of the important operations of this arsenal and the nice and costly machines employed thereon are still in the several small detached one-story brick buildings, erected for and suitable for the manufacture of paper cartridges in 1818, and a small modern brick machine shop and temporary wooden buildings, added to the arsenal in haste during the pressure of manufactures during our civil war. The buildings are not suited to the work, are so old as to involve undue expense for their maintenance, and are not adapted to the best and most economical management of the work. Their capacity is barely sufficient for providing for the current wants of our Army and militia, and, although they are unduly crowded, it is impossible to provide for the accumulation of a reserve supply of this most important ammunition. This reserve supply would be sorely needed, and the lack of it would be the first felt in case of any emergency requiring the increase of our military establishment.

The proposed utilization of the new building mentioned above would furnish space for an increase of the product of small-arm cartridges to about four times the present capacity of the arsenal, and would provide for more economical work.

It would also leave sufficient space in so much of the present shops as would be retained for the manufacture of the ammunition required for modern field and siege artillery.

An estimate of about $53,000 for the utilization of this building, and the other improvements described above, has been included in my annual estimates for several years. I regret that Congress has deferred action on this estimate from year to year, and it is hoped that action thereon may be obtained from Congress at its next session. The estimate this year is increased to $65,310 in order to provide a portion of the new machines that would be necessary for the increase of annual product proposed. I regard this provision for the increase of our capacity for the manufacture of metallic ammunition as of vital importance to our military establishment.

SANDY HOOK PROVING GROUND.

Firings for experimental and proof purposes have been carried on as usual during the year whenever the weather and other circumstances would permit. These firings, with their object and character, are fully summarized in the pages appended to the report of the commanding officer, Sandy Hook Proving Ground. 7

The machine shop pertaining to this post has been increased by the addition of a number of new and necessary tools, such as a Niles planer, 32 by 32 inches, to plane work 10 feet in length; one 14-inch stroke Niles slotter, to slot to center of 60 inches; one Brown & Sharp universal milling machine, No. 4, complete, with change gear, index plates, and tables; one Fitchburg engine lathe, 16-inch swing over ways, bed 8 feet long; and one Pond new pattern 42-inch triple-geared engine lathe, with bed 26 feet long, to turn 7 feet between centers. These tools are now being put in position, and will add greatly to the efficiency of the shop.

The repairs at the wharf, to the length of some 224 feet by 30 feet 6 inches in width, have been completed in a very satisfactory and economical manner, resulting in the substantial and durable improvement of the wharf.

The following guns, mortars, and carriages of modern construction have been issued from this post for installation in seacoast fortifications built especially for their reception:

To Fort Hamilton, New York Harbor:
    One 10-inch B. L. rifle, steel.
To Fort Wadsworth, New York Harbor:
    One 8-inch disappearing carriage.
    Five 8-inch B. L. rifles, steel.
To Willets Point, New York Harbor:
    Two 10-inch B. L. rifles, steel.
To Fort Point, San Francisco, Cal.:
    Two 10-inch B. L. rifles, steel.
    One 10-inch disappearing carriage.
To Sullivans Island, Charleston, S. C.:
    Six 12-inch mortars, cast-iron, steel-hooped.
    Seven 12-inch spring-return mortar carriages.

The railway pertaining to this post, and by which connection is made with the Central Railroad of New Jersey, continues to prove a source of great convenience and economy in the movement of heavy ordnance and other stores. The road has been improved and strengthened during the year by the removal of old and wornout ties and rails and replacing them with new ones. All that portion of the road connecting the battery with the lines purchased from the Central Railroad has been thoroughly ballasted, using for the purpose the stone taken from the old cribs of the wharf, and, in addition, 80 carloads of furnace slag. The latter proves to be especially adapted to sand, and the substantial character and durability of the road have been greatly increased by its use.

SMALL ARMS AND SMALL-ARM AMMUNITION.

The armament of troops in the regular service and of the cadets at the Military Academy with the new .30-caliber magazine arms was completed in May, when the last issue of carbines was made to the cavalry. The first issue of the carbines was made on the 10th of March preceding.

The magazine rifles and carbines now being manufactured are known as model 1896. All of the carbines are of this model. The rifles in service are principally of model 1892, in which some of the improvements of model 1896 have been introduced either before or since their issue. The rifles furnished the cadets of the Military Academy are of the regular .30-caliber service pattern, model 1896, except the bayonet and ramrod, with minor details controlled thereby. The bayonet is shorter than the service pattern and the ramrod is in one piece (model 1892).

The parts of the rifle, model 1892 and model 1896, and of the carbine, model 1896, and a description of the changes introduced in the latter model, have been published to the Army, together with instructions for requisitions for spare parts to repair arms in the hands of troops, in General Orders, No. 14, Headquarters of the Army, Adjutant-General's Office, March 31, 1896. The changes due to unsuitable metal or defects of construction observed in the rifles already issued have, it is believed, been wholly or principally overcome in the model 1896, and parts of the rifles in service of which complaint was made have been so far as practicable in the hands of troops replaced by the improved parts. The rear sights of the earlier pattern in service have been entirely replaced by those of the latest model. These sights provide for a continuous adjustment in elevation, and will enable the soldier to correct his aim in any case for "high" or "low" shooting. As regards direction, the sight notches in the leaf and slide are placed in the vertical plane containing the axis of the bore. This position is found to give a close correction for drift at all ranges up to 1,000 yards. Under normal conditions, in calm weather, no drift is found up to 500 yards, and between that and 1,000 yards the drift is slight, tending to the left rather than to the right.

Extended firings have been made during the year both at the armory and at the Sandy Hook Proving Ground (for extended ranges) to fix the sighting of the .30-caliber arms, and to determine the trajectory, drift, and effect of wind upon the bullet for different ranges. The data will be compiled in the revised description of the rifle and carbine which is now being prepared, which will also include the changes of construction introduced since the first edition of this pamphlet, which was published in 1893.

Steel for gun barrels.—The most satisfactory metal that could be procured, and that which has been used for barrels during the year, is a Bessemer steel, which, when tested from the bars as delivered by the manufacturer, shows a tensile strength of about 120,000 pounds and an elastic limit of 67,000 pounds. The metal, when rolled into shape for barrels at the armory, could not be worked satisfactorily without being annealed, and from this the tensile strength and elastic limit were reduced respectively to 98,000 and 57,000 pounds in test specimens. These properties are below what is preferred for the gun barrel, and the search for a steel possessing higher physical qualities and more uniformity of structure at reasonable cost is still in progress. The results of these tests, together with those derived from different methods of annealing and treatment to avoid lowering the physical qualities of the metal, while reaching a good condition for machining the barrels, are given in the appended report of the commanding officer of the armory.

When the bar was rolled into a barrel, the best results were obtained by simply cooling in air. These barrels, however, worked badly, many being too hard to drill or turn accurately. It appears to be essential to anneal the carbon steels before they can be worked with certainty and accuracy in the machines used, in order to correct for hard spots and want of homogeneity in the metal.

Sample barrels made from oil-tempered and annealed nickel steel are now being tested. But, however satisfactory these tests may prove, the working of this metal presents difficulties which must be overcome before such barrels can be generally used.

The material from which barrels have been made during the year can, it is considered, be employed with safety. Several rifles tried have withstood registered pressures of from 80,000 to 90,000 pounds. No undue enlargement of the chamber has occurred, and no excessive wearing of the grooves or marked erosion from the powder has appeared after firing several thousand rounds. One rifle has been fired 13,338 rounds, another over 8,000 rounds, and several over 5,000 rounds, using the service ammunition, and still remained in a serviceable condition.

Shotguns.—An appended report gives the result of a satisfactory trial of the 12-bore Winchester repeating shotgun, model 1893. A description of this arm has been prepared and published separately by the Department for the information of the Army. A limited number of these guns were procured in 1895 for the use of guards to prisoners at posts in thickly settled country, where the use of the new rifle, with its long range and great penetration, would be dangerous to the community.

SMALL-ARMS AMMUNITION.

The three kinds of ammunition provided for the .30-caliber magazine rifle and carbine are the ball and blank cartridges, and the gallery-practice cartridge case, which is loaded by the troops. There is no distinction in the ammunition for the rifle and carbine. During the past year new patterns of the blank cartridge and the gallery practice case have been introduced in service.

The blank cartridge, model 1896, is made with a paper bullet inserted in the regular service-cartridge case in place of the metal bullet, and makes a cartridge of the same dimensions outwardly as the ball cartridges. This similarity of dimensions is requisite to enable the blank cartridge to be loaded in the same manner as the ball cartridge, either singly or through the magazine. The whole charge consists of 10 grains of smokeless (E. C.) powder, 5 grains in the case, and 5 grains contained in the hollow of the bullet, which causes complete disruption of the paper bullet before it leaves the piece. The former model of metal blank cartridge contained a charge of 65 grains of black powder. The change which has been effected will result in a material decrease in the cost of production, and it is considered that the use of smokeless powder blank cartridges will be a decided advantage in the drill and exercises of the troops, to accustom them to the effect of firing with smokeless powder.

The gallery practice case, model 1896, is simply made from the regular service case by compressing the latter with a groove made on the exterior at 0.25 of an inch from the mouth to form a seat for the round ball in the mouth of the case. The charge is 5 grains of black powder. A considerable saving in cost is effected by the change to this case from the former model that was made of thick metal turned and bored from a solid brass rod. Information of this change of model was announced to the service in General Orders, No. 23, Headquarters of the Army, Adjutant-General's Office, 1896, with instructions for gallery practice firings.

With the strengthening of the regular service case referred to in the last annual report, the .30 caliber ball cartridge has given good results in practice, obviating, as was expected, the bursting of the case near the head that was occasionally observed in the earlier cartridge. Further changes introduced in the past year, which are fully described in the appended report of the commanding officer, Frankford Arsenal, may be briefly referred to. A slight cannelure is made on the surface of the bullet, into which the mouth of the case is crimped to prevent telescoping of the bullet, or any change in the length of the cartridge in handling, whereby facility of loading from the magazine and the shooting qualities of the cartridge might be impaired. The use of copper in place of brass for the primer cup has been revived, and a priming composition has been found that produces ignition of the several varieties of smokeless powders without any hang-fires. The charge of composition is 0.35 of a grain by weight, and consists of fulminate of mercury (moist), 59.37; chlorate of potash, 21.89; glass, 15.62, and mealed powder, 3.12 parts in 100.

Promising results were obtained with small lots of cupro-nickel made in this country for bullet jackets, but in endeavoring to procure the metal in quantity it was found to be variable in quality and not reliable enough to replace the cupro-nickel steel jacket metal already in use, which is manufactured abroad.

The results obtained in the daily firings for tests of ammunition at Frankford Arsenal evince the general excellence of the ammunition and performance of the .30-caliber magazine rifle.

The following table shows the comparative accuracy at 500 yards of the caliber .45 and caliber .30 rifles, derived from 1,000 consecutive targets of 10 shots each, or 10,000 rounds for each rifle. The rifles in these firings were held in a fixed rest, which eliminates inaccuracies due to personal errors in aiming. In this whole series of firings there were possibly four dropped shots from the magazine rifle, due to any cause.

Caliber .45.		*Caliber .30.*	
Beginning May 23, 1893.		Beginning July 25, 1894.	
Ending March 5, 1895.		Ending May 22, 1895.	
Number of targets	1,000	Number of targets	1,000
Mean radius	0′.7771	Mean radius	0′.6161
Maximum radius	1′.15	Maximum radius	1′.020
Minimum radius	0′.48	Minimum radius	0′.360
Extreme variation	0′.67	Extreme variation	0′.660
Mean vertical deviation	0′.5604	Mean vertical deviation	0′.4520
Maximum vertical deviation	1′.010	Maximum vertical deviation	0′.795
Minimum vertical deviation	0′.280	Minimum vertical deviation	0′.210
Extreme variation	0′.730	Extreme variation	0′.585

The comparative uniformity of velocities obtained with the caliber .45 and caliber .30 rifles is shown in the following table:

Caliber .45.		*Caliber .30.*	
Beginning September 7, 1893.		Beginning July 25, 1894.	
Ending March 5, 1895.		Ending May 22, 1895.	
553 sets of 6 shots each.		547 sets of 10 shots each.	
Total, 3,318 shots.		Total, 5,470 shots.	
	Feet per second.		Feet per second.
Mean velocity	1,276.46	Mean velocity	1,977.04
Maximum velocity	1,299	Maximum velocity	2,008
Minimum velocity	1,259.5	Minimum velocity	1,951.7
Extreme variation	39.5	Extreme variation	56.3

The extreme variation in velocity of the .30-caliber magazine rifle, firing smokeless powder, is seen to be slightly less, taken as a percentage of the initial velocity of the bullet, than that of the .45-caliber Springfield rifle firing black powder.

After firing 13,338 rounds from one caliber .30 magazine rifle it was used in making two targets of 10 shots each at a range of 500 yards with the service cartridge charged with Peyton powder. The radii of the circle of shots obtained were, respectively, 0.4 and 0.44 foot. The muzzle velocity of this rifle when compared with that of a new rifle was found to be slightly reduced, due to the wear, but it varied less from shot to shot, and as the record shows, maintained excellent practice in shooting.

Tweedie bullet.—Questions that have arisen regarding the "stopping power" of the modern small-caliber bullet, particularly in view of the reduction of the caliber of the rifle in some services to 0.25 inch, or even less, have led to propositions to adopt soft-nose or "mushrooming" bullets, which will be deformed on striking an animate object, inflict a more dangerous wound, and increase the shock over that given by a hard bullet of the same caliber and weight, which would penetrate the body without deformation. Experiments with our .30-caliber rifle, using one of the best forms of these bullets brought to the notice of the Department, have been made at Frankford Arsenal, and the report is appended.

Direct comparisons were made by firing this and the service bullet, which, taken in connection with the nature of wounds evinced by the service bullet in previous experiments, lead to conclusions decidedly in favor of the service bullet for general purposes of warfare. The mushrooming effect of the soft-nose bullet is offset by the so-called explosive effect of the hard-pointed bullet at short ranges. The soft-nose bullet is inferior in accuracy, and is especially inferior in its ability to penetrate hard substances used for defensive purposes, making it almost useless to reach troops under cover that would be dislodged by the service bullet.

Smokeless powder.—Smokeless powder of American manufacture is exclusively used in the manufacture of .30-caliber rifle and carbine ball cartridges for the service. It is procured by contract for delivery and inspection at the Frankford Arsenal. The powder chiefly used is the "Peyton," furnished by the California Powder Works, but considerable portions of the amount required have been procured from Du Pont & Co. and the American Smokeless Powder Company. The last-named firm has recently been incorporated with the Laflin & Rand Powder Company.

The specifications for this powder remain practically the same as published in my last annual report. Under the ordinary tests it is required to give in the .30-caliber rifle, with a determined charge of powder and the standard 220-grain bullet, a muzzle velocity of 2,000 feet per second with a pressure not exceeding 38,000 pounds per square inch. The Peyton and Du Pont powders fulfill these requirements with a charge of about 36 grains and the American powder with a charge of about 42 grains. The appended report of the chemical laboratory at Frankford Arsenal gives the records of tests of these powders and of samples furnished by the Giant Powder Company, of California. The keeping qualities of the powder have been severely tested, and these tests will be continued.

Cartridges made from the several varieties of service powders were subjected to open-air exposure on the roof of the laboratory through periods ranging from nine to fourteen months, and then tested in comparison with others of the same original date of manufacture that had been stored with care. The stability of the powder was not impaired, but rather improved; the loss of velocity was, however, in some instances considerable, ranging from a few feet to 148 feet per second as a maximum in five lots under treatment. The exposure, which was continued through winter and summer months, was very severe, as was shown by the effect of weather upon the exterior of the case and bullet.

Two other lots of cartridges were tested when returned to Frankford Arsenal, after storage for periods of six, nine, and twelve months in the dry climate of Whipple Barracks, Ariz. The powder in these cartridges showed no loss of stability, and there was but slight change in velocity when compared with cartridges retained in the damp climate of the arsenal or from the velocity observed when the cartridges were first made.

The samples of smokeless powder for the .30-caliber rifle last furnished by the Giant Powder Company have given favorable results when tested, both at the Benicia and Frankford arsenals. Renewed tests have been made of samples of Volney powder without as yet reaching satisfactory results. A test made of a sample of so-called pure guncotton powder, furnished by the Maxim Powder Company, showed that for a charge suited to give the standard velocity the pressures exceeded the limit allowed by the present specifications.

MACHINE GUNS.

The thirteen 10-barrel Gatling guns, caliber .30, with Bruce feed, contracted for by the Department January 16, 1895, and made for the Gatling Gun Company by the Colt's Patent Firearms Manufacturing Company, were delivered by December 1, 1895.

This is the second lot of caliber .30 Gatling guns procured by the Department, and though there is still room for improvement in some of the features, they are, it is believed, superior for the military service to any machine gun for small-arm cartridges that has yet been presented in this country. They use the same ammunition as the .30-caliber magazine rifle and carbine.

The 18 Gatling guns, caliber .30, model 1893, previously procured, are now being altered to model 1895 at the Springfield Armory.

These guns, with a number of caliber .45 Gatling guns on hand, are available for use in the permanent fortifications now being constructed. For this purpose they will principally be required on a movable mount, for which the metallic carriage for machine guns, model 1890, will be suitable.

A report of the Ordnance Board on the test of a Maxim .303-caliber automatic machine gun, single barrel, which was referred to in the last annual report, is appended herewith. This gun is designed for infantry service. For the purpose of carrying the gun and its folding tripod, a knapsack of leather has been designed, into which both can be packed and shouldered in less than half a minute. The combined weight of the gun, tripod, and knapsack is 50 pounds, and the weight of an ammunition box containing 100 rounds is 8 pounds. The firing tests of the gun were limited to between 500 and 600 rounds, and are not regarded as sufficient for the purpose of adoption in the service.

A second Colt's .30-caliber automatic machine gun, single barrel, modified in some respects on the pattern of which the test was reported last year, has been presented and tested at the Springfield Armory, with results, however, that are not considered sufficiently satisfactory to warrant the adoption of this arm in the service.

ARMAMENT OF FORTIFICATIONS, ETC.

GUNPOWDERS.

Charcoal powders.—The completion of a number of emplacements and the mounting therein of guns and mortars at some of our more important seaports has furnished an opportunity for instructing the artillery troops in the service of the new seacoast armament and for some practice firing. Accordingly the issue of ammunition to the service was begun during the past year, and instructions were prepared for putting up cartridges. The practice charge for guns being less than the service battering charge, it is essential, in order to avoid the occurrence of excessive wave pressures, that the cross section of the cartridge be so adjusted that the charge shall occupy practically the whole length of the chamber. The charges of brown powder used for modern high-power guns are large, consisting of 125 pounds for the 8-inch, 250 pounds for the 10-inch, and 450 pounds for the 12-inch. The grains of these powders are molded, and it takes considerable time to build up the cartridges from the grains. In consequence, cartridges for these guns must be furnished from the ordnance establishments built up ready for use. Owing to the weight, the charge for the 8 and 10 inch guns is divided into two portions, and that for the 12-inch gun into four portions. For preservation, transportation, and storage it has been found necessary to place each cartridge forming a portion of the charge into separate receptacles called storage cases. These cases were originally made in the form of zinc cylinders lined with straw board with covers which admitted of hermetical sealing, and with large loop handles for transferring them from point to point. Further investigation indicated that a wooden case tin lined would effect the purpose at much lower cost, and arrangements are being made to supply them.

Hermetical sealing is obtained with the wooden cases, and arrangement for transportation for short distances by the use of large rings attached to the heads is also made. The new form of case, in addition to being cheaper, is less liable to injury than the zinc cylinder now in use, and being rectangular instead of cylindrical in section, it is more convenient for transportation and for packing in the service magazines.

For the 12-inch mortars, which have short chambers, the precaution of maintaining the length of the reduced charges by a reduction of the cross section is not necessary.

Experiments have been made to determine whether the regular arrangement of the prisms of brown powder exercised any influence on the ballistic results, certain firings for the 12-inch mortar having been conducted at the Sandy Hook Proving Ground with this object in view. The results indicated that whenever the charge will allow it the cartridges need not be regularly packed for the mortars; that is, with less than 80 pounds for the steel and less than 58 pounds for the cast-iron hooped mortar. With the guns, the charges are generally of such size that they would more than fill the chamber if not packed, and packing is therefore necessary on this account.

As pointed out in my last annual report, all charcoal powders vary in quickness with the season, being quicker in summer and slower in winter than in their normal condition. This is particularly true of brown powder, which it has been found may change materially, even when hermetically sealed, and when no actual deterioration is going on. The change in pressure is sometimes as great as 10 per cent between winter and summer, or 5 per cent on each side of the normal. As respects the variation in the velocity, it seems probable that the variation does not exceed 2 per cent on each side of the normal, and generally falls considerably within that value. It is deemed quite essential that cartridges of brown powder should never be exposed, but should be placed in storage cases as soon as made and kept there until the time of firing.

For economy, the Department has substituted a new packing box for the iron and wooden barrels heretofore used for packing powders. The box is of wood, lined with tin, and hermetically sealed by means of a gasket. It is strong, compact, and of convenient size and shape for handling and storage. These boxes are very cheap.

A wooden, tin-lined cartridge storage case has also been adopted for service. This box is similar in construction to the packing box, except that the top is fastened on differently, and handles for carriage are attached. The cost of this box is less than half that of the zinc cylinders now in use.

Steps have been taken to make the granulation of prismatic and sphero-hexagonal powders uniform, in order that it may be used in making changes, or even in putting up charges without scales, if necessary. The granulations of the three sizes of sphero-hexagonal powders are 64, 96, and 128 to the pound, or 4, 6, and 8 to the ounce. These sizes are intended for the 8-inch converted rifle and 15-inch smoothbore, the 12-inch mortar, and siege cannon of all kinds, and the field cannon, respectively. Each size, if desirable, can be used for the manufacture of the class or classes for which the next size is intended, and hence the output of any particular kind of powder can be doubled in case of need.

A system of designating and marking the different powders and different lots and of marks for the packages has been adopted for service. Under this system each lot is designated by the kind of powder, the piece for which intended, the name of the manufacturer or place of manufacture, the number of the lot for the year designated, and the year of delivery. The service for which each package is designed is thus clearly indicated, and at the same time the necessary data is given for readily referring to the record of its manufacture.

While it is anticipated that smokeless powder will soon be adopted for the greater portion of our cannon, it has been thought well to have the manufacture of charcoal powders well systematized, so that we might have recourse to them, if necessary, in time of emergency. The following may be considered the system of charcoal powders for the use of our service:

Black granular, .45 cal., Springfield rifle; gran., 0.03″-0.06″.
Black granular, 3″ Hotchkiss mountain gun; gran., 0.10″-0.15″.
Black sphero-hexagonal for field cannon; gran., 128.
Black sphero-hexagonal for siege cannon and 12″ mortars; gran., 96.
Black sphero-hexagonal for 8″ converted rifle and 15″ S. B. gun; gran., 64.
Brown prismatic for 12″ B. L. mortars; gran., 10 (about).
Brown prismatic for 8″ B. L. rifle; gran., 10 (about).
Brown prismatic for 10″ B. L. rifle; gran., 10 (about).
Brown prismatic for 12″ B. L. rifle; gran., 10 (about).

These powders have all been manufactured, the detailed records of manufacture are on file, and the molds and presses are on hand, so that no difficulty is anticipated in producing any of the above kinds that may be called for rapidly in large quantities.

Saluting powder.—The saluting powder recently adopted has been found so much more efficient for blank cartridges than the ballistic powders formerly used as to admit of a reduction of the charge to about three-fifths of that formerly employed, which will result in considerable economy. Some difficulty has been experienced in keeping the blank cartridge of the field gun in the chamber and sufficiently near the breech to secure certain ignition of the primer, but this difficulty can be overcome by making the cartridge of the full diameter of the chamber, so that it will not slide forward into the bore, and even when such cartridge is pushed forward in the chamber the ordinary friction primer will still ignite it with certainty.

Smokeless powders.—As regards the further development of smokeless powders during the year, some very satisfactory results have been obtained with Maxim-Schupphaus smokeless powder in the 12-inch B. L. mortars, using both full and reduced charges, by means of which the power of the cast-iron hooped mortar is brought up to that of the steel mortar using brown powder. Thus, with a charge of 42 pounds of this powder and an 800-pound projectile, a muzzle velocity of 1,154 feet, with a pressure of about 24,000 pounds per square inch, was obtained, which is about the same ballistic result as is obtained with the steel mortar using brown powder, but with a reduction in pressure of about 6,000 pounds per square inch. Smokeless powder is also being tested in the field and siege mortars. In the main, however, development of smokeless powders has been more in the direction of an investigation into the properties and relative advantages and disadvantages of various compositions than in that of the development of higher ballistic properties.

A set of comparative experiments has been carried on in the .30-caliber service small arm and the 3.2-inch field gun with metallic case ammunition and powders of five different compositions, as follows: Maxim-Schupphaus, but containing 10 per cent of nitroglycerin; the Peyton composition; a composition consisting of plain gun cotton yielding about 13 per cent of nitrogen; a composition containing 25 per cent of nitroglycerin, the remainder being low-grade gun cotton yielding 11 per cent of nitrogen; and a composition known as the "W. A." XX powder, furnished by the American Smokeless Powder Company. These compositions were selected as typical of various compositions known to be suitable for powders, most of which consist substantially of gun cotton, high or low grade, with or without nitroglycerin and nitrates. The compositions were made up into powder suitable for .30-caliber small arm and the 3.2-inch field gun, except that the composition last named above was not tested in the latter piece. The results of the tests are fully discussed in the report of the inspector of powder, which forms an appendix to this report, as respects ballistic qualities, stability, and erosion.

As respects ballistic qualities, it is concluded that the smokeless powder will lead to an increase in accuracy of fire, as well as to an increase in power. As respects stability, whether chemical or mechanical, no trouble is anticipated on either score. All the five compositions showed an increase in velocity and pressure when heated and fired hot, and a loss when fired cold; but it is thought that the changes are no greater than charcoal powders would show under similar conditions. They are but slightly affected by moisture, and almost none at all by drying beyond the normal state. In this important respect they are far superior to the charcoal powders. Moisture does not appear to affect the interior of the grain at all, and only affects the results through its presence on the surface, and the qualities of the powder are completely restored by drying in the open air. Samples of the first four compositions given above in the form of field-gun powder were kept submerged in water for fifteen hours, and after drying in the air showed no loss of ballistic effect, and all five compositions in small arms powder were subjected for thirty minutes to a temperature of

10° F. below zero, and then raised to a temperature of 80° F. alternately thirty times, and showed no change in ballistic effects or under the microscope.

The erosive effects of smokeless powder are generally considered to be serious, but this defect is not so serious as to counterbalance the advantages attendant on their use. It is important that powders that are satisfactory in other respects be examined in relation to this one, in order that the most advantageous compromise between the good and the bad may be made. In the tests made in the small arm for erosion with the five compositions, the erosions produced by the Maxim-Schupphaus were quite slight; those by the "W. A." XX powder very great. They were mainly confined to a space withih 2 inches of the seat of the bullet, and had caused no loss of velocity except in the case of the last-named composition, in which the velocity had fallen off about 150 feet. The compositions arrange themselves in the same order in heating and erosive effects, and not only that, but the intervals are much the same. The conclusion was also reached from these experiments that, whether the proximate cause of erosion be of a mechanical or chemical nature, heat is the original disposing cause. It would seem, therefore, that the erosive effect can be approximately predicted from a determination of the heating effect, and both with some degree of approximation from a knowledge of the composition; and further, that the great heat of nitroglycerin can be so modified by the use of other suitable ingredients in a powder as to reduce the heat and erosion to any desired point. Hence there may be no objection on the score of erosion to the use of nitroglycerin with suitable accompanying ingredients in smokeless powders.

The form of grain is of great importance with smokeless powders, since, unlike the charcoal powders, they possess the property of burning by parallel surfaces in the gun. This property gives the powder maker great advantage in designing the form of grain so as to obtain a progressive combustion of the charge, based on the amount of burning surface. Experiments have shown that the most satisfactory form of grain, as being the most progressive, is the multiperforated cylinder, and as by increasing the number of perforations a grain of any desired size may be obtained for any given thickness of the walls between the perforations, it would seem that by this method a free and unhindered inflammation of the charge could be obtained and at the same time the maximum of ballistic power realized for a given type of powder.

Proving ground for powder at Springfield Station, Pennsylvania.—The installation of this proving ground now comprises the following pieces, together with the necessary carriages, chronographs, pressure gauges, etc., necessary for their use:

One 8-inch B. L. rifle, model 1888.
One 3.6-inch field gun, model 1891.
One 3.2-inch field gun, model 1890.
One .30-caliber magazine rifle, model 1892.

To which may be added for practical use the following belonging to the Du Pont Company:

One 6-inch naval B. L. rifle.
One .30-caliber pressure barrel.
One .45-caliber Springfield rifle.
One .45-caliber Springfield rifle, pressure barrel.

Nearly all the necessary tests of samples can be made by means of these pieces, and they have been generally in use during the year for that purpose. Fifty-six rounds, mostly brown powder, have been fired during the year from the 8-inch gun and 100 rounds with smokeless powder from the 3.2-inch gun.

MANUFACTURE AND TEST OF POWDERS ON THE PACIFIC COAST.

Charcoal powders.—The manufacture of charcoal powder on this coast during the year has been limited to a lot of 2,500 pounds of saluting powder for 10-inch muzzle-loading smoothbore guns, and a quantity of brown powder for the 12-inch B. L. rifle, steel, and 12-inch B. L. mortar, cast iron, hooped, and black molded powder for 12-inch B. L. mortar, cast iron, hooped, a contract for this powder having been placed with the California Powder Works for issue to the service for firing instruction in target practice. The powders for the rifle were proved in the 12-inch rifle at Fort Winfield Scott, San Francisco Harbor, and the powder for the mortar was proved in part at the same point and in part at the Benicia Arsenal as soon as a mortar could be mounted for the purpose. The powders furnished by the manufacturers passed the required test satisfactorily and were accepted.

Smokeless powders.—Little progress has been made in the development of smokeless powders on this coast since my last annual report. The Giant Powder Company has purchased and set up a Boulengé chronograph, and has now a well-equipped testing plant for small-arms powders. The United States Smokeless Powder Company has experimented during the year with powder for 3.2-inch field gun, but without satisfactory results. But one new variety of smokeless powder for small arms has been tested during the year. This is called "Italian smokeless powder," and is made by Parlato & Salamone, of San Jose, Cal., manufacturers of and dealers in fireworks. It is a white powder in appearance, and is made by hand in small round grains which are not too hard to be crushed between the fingers. When ignited it burns with a white, bright flame; it produces little smoke and leaves but a slight residue in the bore. The makers claim that the powder is not affected by heat or cold.

Proving ground at Benicia Arsenal.—The manufacture on the Pacific Coast of the powder required for the service of the posts on that coast saves the considerable cost and difficulty attending transportation from the East, but necessitates provision for testing the powder also at some convenient place on the Pacific Coast. The place selected is the Benicia Arsenal, and a beginning has been made toward carrying out the plan of providing a proving ground by mounting a 12-inch mortar on the site selected and erecting the necessary screens for the measurement of velocities. The mortar carriage used was economically converted from a 15-inch barbette carriage, and permits horizontal firing only.

SEACOAST GUNS.

The firings with the several type guns under test have been completed during the year.

Ten-inch B. L. rifle, type.—The requirements of the powder for the test of this gun were as follows: Charge, 250 pounds; projectile, 575 pounds; pressure per square inch, 37,000 pounds; initial velocity, 1,975 feet per second.

The gun has endured 292 rounds without any apparent loss of strength. Of this number 144 rounds have given pressures above 35,000 pounds per square inch. The maximum pressure obtained was 62,600 pounds per square inch. The erosion of the tube for some distance in front of the seat of the projectile is now so great as to destroy the accuracy of fire, and for that reason alone the gun is considered unserviceable. As was to be expected, the erosion increased very rapidly toward the last. Up to about the two hundredth round the accuracy of the piece was not materially affected by this erosive action. Soon after this, however, it was found that the projectiles with the service band did not take the rifling well enough to insure accurate flight. Accordingly, a projectile was used having a band of the same form as the service band, but one-tenth of an inch greater in diameter.

The effect of this was to restore the accuracy of fire. After the two hundred and fiftieth round the erosion had progressed so far as to make necessary a further increase in diameter of band. This second increase produced results as satisfactory as those obtained by the first increase. At the two hundred and eighty-eighth round, however, this advantage disappeared. Out of five shots at the 3,000-yard target but two hits were obtained, as against a record of five hits at the same range with the five shots immediately preceding. As the travel of the shot had not materially decreased, it was not thought that the difficulty could be overcome by further increase in thickness of band. From an inspection of the extent of the eroded portion of the bore it seems probable that the velocity acquired by the shot before reaching the uninjured portion of the rifle is sufficient to partially shear or tear the band, so that the full velocity of rotation is not imparted.

Some trouble was experienced with the gas-check cups originally used with this gun, but the difficulty was entirely removed by the substitution of steel split rings for the steel cups. Two spindles of the mushroom head were broken during the test, owing to defective construction, and in one instance owing in part to the excessive pressure, 62,600 pounds per square inch, obtained in the gun. Also two teeth in the rotating pinion were broken. Some defects were also noticed in the tray latch, all of which are overcome in the service guns.

The gun was tested for accuracy, rapidity, etc., and carefully star-gauged at intervals during the test. In the opinion of the board the gun has successfully withstood a fire of 292 rounds, and as a result of this test no injury, except that due to erosive effects of the powder gases, can be detected. This erosion has destroyed the accuracy of fire, and for this reason alone the gun in its present condition is considered unserviceable, and the board concludes that it is a suitable gun to be put in the Government service. In view of the otherwise good condition of the gun, the board is further of the opinion that it is desirable to have it relined and submitted to further test.

Crozier 10-inch wire gun, experimental.—This gun was turned over to the Board for Testing Rifled Cannon after it had been fired 275 rounds, and was then so eroded as to be no longer in suitable condition for fire. Members of this board were, however, members of the Ordnance Board under whose supervision the firings had taken place. From an examination of the gun and of results of firings made by the Ordnance Board, the testing board finds that the general programme adopted for the 10-inch B. L. rifle, steel, was followed in this test, and that the gun satisfactorily met all requirements as to rapidity, accuracy, and general efficiency. The gun was designed for a pressure of 42,000 pounds per square inch and a muzzle velocity of 2,100 feet per second, using from 260 to 290 pounds of brown prismatic powder and a projectile weighing 575 pounds. A total of 275 rounds were fired, of which 20 gave pressures below 35,000 pounds per square inch, 14 between 35,000 and 40,000 pounds, 231 between 40,000 and 45,000 pounds, and 10 over 45,000 pounds. The maximum pressure was 46,000 pounds per square inch.

As already stated, the gun was so eroded at the commencement of the rifling that the board did not consider it judicious to subject it to further firing, if relining of the tube is contemplated. The board considers the endurance of this piece as entirely satisfactory and that it has been subjected to the proper test for the determination of the endurance of the same, and therefore considers it a suitable gun to be put in the Government service. It is considered also desirable to test the effect of relining the tube, and the board recommends that this gun be relined and subjected to such further tests as may be desirable.

Twelve-inch B. L. rifle, type.—The ballistic requirements of this gun for test were as follows: Charge, 450 pounds brown powder; initial velocity, 1,975 feet per second; pressure, 37,000 pounds per square inch.

As the development of a brown powder suitable for 12-inch guns was carried on with this gun, the above ballistic results were not obtained until the test had been more than half completed.

This gun has been fired 227 rounds, of which number 135 rounds have given pressures above 35,000 pounds per square inch. The maximum pressure recorded was 73,800 pounds per square inch. As a result of these firings, the only injury discoverable is that due to the erosion of the powder gases. In all other respects the gun is apparently able to endure an indefinite number of additional rounds. The erosion, however, has now proceeded so far as to affect the accuracy of fire. For this reason, and also to permit the relining of the gun, the board suspended further test. The effect of the erosive action upon the accuracy was not material until after the one hundred and eighty-fifth round. The diameter of the band was then increased one-tenth of an inch, with marked effect upon the accuracy of fire, both velocity and pressure being brought up at the same time to the normal.

As this was the first gun of this caliber with which the new breech mechanism had been tested, some trouble was experienced which led to certain modifications during the trial. The steel cups in front and rear of the gas-check pad were replaced by split rings. The pinions of the rotating gearing were found too weak, and were replaced by shrouded gears. The tray latch-spring bolt also proved to be too weak, and was strengthened and modified in form. It was also made apparent that the translating stud did not afford sufficient bearing surface and was too easily deformed. This latter feature has been modified on all 12-inch guns made since the type gun, and a bolt added for locking the block to the tray when the block is opened. Some difficulty was also experienced in the action of the locking nuts on the end of the spindle of the mushroom head, causing a tightening of the pad and rendering rotation of the block difficult. It is believed, however, that all these difficulties have been more or less overcome, and that this breech mechanism may now be considered fairly satisfactory for 12-inch guns.

In procuring additional forgings for the further manufacture of 12-inch guns the Department has changed the model of the breech mechanism, with the expectation of obtaining a more perfectly satisfactory action. Any trouble, however, with the locking nuts of the spindle and with the pad will be found inherent in this new system as well as in the present.

Owing to the delay in placing this gun upon a mount where the trial for rapidity could be made, this trial was made with another 12-inch rifle, which, after proper adjustment, gave a rapidity of five rounds in twenty-two minutes.

In the opinion of the board, the 12-inch B. L. rifle, steel, type, has been subjected to the proper test for the determination of the endurance of the same, and the board therefore considers that this gun is suitable to be put in the Government service.

A full report of the tests, including results for accuracy, is contained in the report of the board, which forms an appendix to this report.

The number of seacoast guns manufactured at the gun factory up to the end of the last fiscal year, June 30, 1896, and the years of their manufacture, are as follows:

Year.	8-inch rifles.	10-inch rifles.	12-inch rifles.	12-inch mortars.
1890	[a]1	[a]1	....	....
1891	....	....	[a]1	7
1892	12	....	....	18
1893	....	18	5	48
1894	12	5	3	4
1895	5	8	3	3
1896	10	9	9	....
Total	40	41	21	80

[a] Type.

In addition to these, the West Point Foundry Company finished and assembled eleven 8-inch guns in the fiscal years ending June 30, 1893, June 30, 1894, and June 30, 1895.

And the Bethlehem Iron Company, under its contract of November 7, 1891, for one hundred guns, had finished on June 30, 1896, ten 8-inch guns and fifteen 10-inch guns.

This makes the total number of seacoast guns completed and ready for service on June 30, 1896, sixty-one 8-inch guns, fifty-six 10-inch guns, twenty-one 12-inch guns, and eighty 12-inch mortars.

Under the provisions of the fortifications act of June 6, 1896, a contract for the purchase of 21 additional sets of forgings for 10-inch guns was awarded the Bethlehem Iron Company, and another contract for 21 additional sets of forgings for 12-inch B. L. guns to the Midvale Steel Company.

Congress at its last session also made provision for the manufacture of one type 16-inch gun, the contract for the forgings for which has been awarded to the Bethlehem Iron Company. This gun will be finished and assembled at the Army Gun Factory.

During the past month practice has been had by the artillery troops with the new armament, including guns of 8-inch, 10-inch, and 12-inch caliber, mounted on barbette, gun lift, or disappearing carriages, and also with the 12-inch B. L. mortars, mounted in their emplacements.

SEACOAST MORTARS.

Under the provisions of the fortifications act of June 6, 1896, contracts have been placed in part for the forgings and in part for finished mortars, for 66 additional 12-inch B. L. mortars, steel. Part of the forgings will be finished and assembled by contract with the Builders Iron Foundry, of Providence, R. I., and the remainder at the Army Gun Factory. A contract for 30 finished mortars was awarded to the Bethlehem Iron Company. These mortars will all be completed within the fiscal year ending June 30, 1898.

With this additional lot, the total number of 12-inch mortars for issue to service will be 144, of which number one-half are of cast iron, steel hooped, and the other half are all-steel mortars. In addition to these, one cast-iron hooped mortar has been supplied to the Benicia Arsenal for the proof of mortar powders procured under contract and one all-steel mortar to the United States Military Academy at West Point, N. Y., for the instruction of cadets.

GUN CARRIAGES.

Under the provisions of the last fortifications act additional contracts have been placed for 10-inch disappearing carriages as follows:

Bethlehem Iron Company	12
Southwark Foundry and Machine Company	10
Niles Tool Works Company	8

Orders have also been placed at Watertown Arsenal for the manufacture of an additional lot of five 8-inch, five 10-inch, and four 12-inch disappearing carriages; also for several 12-inch nondisappearing barbette carriages, and for the alteration of three gun-lift carriages to barbette carriages. The funds thus far appropriated are sufficient to provide the following kinds and calibers of carriages:

Total carriages completed, under manufacture, and for which there are appropriations available.

12-inch:	
Disappearing C. P	1
Disappearing F. P	14
Nondisappearing	11
Gun-lift	2
Casemate	1
10-inch:	
Disappearing C. P	1
Disappearing F. P	[a] 64
Nondisappearing	5
8-inch:	
Disappearing F. P	[a] 10
Nondisappearing	8

It is expected that all will be completed within the fiscal year ending June 30, 1898, and there are funds on hand for twelve 8-inch carriages now advertised for.

Some modifications of the disappearing carriage, model 1894, have been introduced with those now under construction, known as model 1896, mainly with the view of increasing the facility and especially the rapidity of maneuvering. They are principally as follows:

Live chassis rollers have replaced the axle rollers. The carriage is mounted upon a single turntable instead of upon a forward turntable and rear traverse circle, as heretofore.

Gun iron has been substituted for cast steel as the material for the chassis rails.

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[a] Exclusive of type carriage.

A chain and sprocket wheel retraction gear has replaced the rope and tackle.

At the shot trial of one of the carriages, model 1894, which had been fitted with live chassis rollers, the saving of counterweight was found to be about 7,000 pounds, and the effort required to haul the piece down by hand was reduced about 50 per cent. No difficulty with this class of rollers was developed at the firing trial of the carriage.

It is expected that mounting the carriage upon a single turntable will reduce by about one-half the time required for traversing, besides affording an increased field of fire.

ALTERATION OF CARRIAGES.

During the fiscal year six barbette carriages, front pintle, with hydraulic cylinders, have been altered at Watertown Arsenal for the 15-inch smoothbore gun. No estimate for continuing this work was submitted to Congress at its last session, as it was thought that the wants of the service as respects these carriages were sufficiently supplied for the present.

MORTAR CARRIAGES.

Under the provisions of the last fortifications act, contracts have been made for sixty-seven 12-inch spring-return mortar carriages of the Gordon type, as follows: Fifty-seven carriages awarded to the Robert Poole & Son Company and ten carriages awarded to the Southwark Foundry and Machine Company.

These carriages will all be completed within the next fiscal year, and will give a total of 150 mortar carriages for issue to service, exclusive of two carriages, one at West Point and one at the proving ground at Sandy Hook, N. J.

RAPID-FIRE GUNS.

Experimental 12-centimeter guns.—The tests of the several types of 12-centimeter (4.72-inch) rapid-fire guns procured by the Department for comparative trial have been completed by the Ordnance Board during the past year, and the results may be summarized as follows:

All the guns were submitted to the same programme of tests, which had for its object to determine velocity, accuracy, rapidity, rapidity with accuracy, effect of shrapnel against steel plates, dispersion of canister, rapidity with accuracy against a moving target, action and effect of dust, rust, excessive charges, defective cartridges, and the endurance.

Schneider 12-centimeter (4.72-inch) rapid-fire gun.—This gun is of built-up steel of 50 calibers total length and weighs 7,168 pounds. The weight of projectile is 48.4 pounds, and of the powder charge, brown prismatic, 26.5 pounds; smokeless, 18.2 pounds. The gun is adapted to either percussion or electrical firing, using metallic ammunition. The character of the breech mechanism is fully described in the report of the Ordnance Board, which forms an appendix to this report. The mount consists of a cradle, chassis, racer, bedplate, shield, and training mechanism. The recoil is taken up by hydraulic brakes, and the piece returned into firing position by means of recuperator springs. The maximum extent of recoil is 8.3 inches. The tests of this gun were carried out in the presence of Commodore Kreyder, of the French army, the representative of the Scheider Steel Works at Creusot.

The board found that the action of the breech mechanism in manipulation and deliberate firing was satisfactory. The number of parts of the mechanism is 61, including 9 springs, which exceeds the number that is usually found in the best modern mechanisms for rapid-fire guns. The use of two levers in operating the breechblock is considered a source of some confusion, except in the hands of a trained operator. The extractor was considered somewhat defective in that it has so little surplus power over that required under normal conditions, which it is thought might affect the rapidity of firing under some circumstances.

At the termination of the operation of closing the breech the right arm of the operator, as well as a considerable portion of his body, is in the rear of the breech of the gun. This is considered by the board a very objectionable feature in a rapid-fire gun. It is particularly objectionable with this gun, for the reason that the extractor guide extends to the breech about 11 inches. The operator manipulating the block is liable to stand close to the end of this guide. If while in this position the piece were discharged, in all probability a fatal blow would be received from the guide by the operator during the recoil. In the excitement of rapid firing this might occur.

An arrangement to prevent premature explosion of cartridge appears to be efficient and satisfactory. The highest velocity obtained in the tests was 2,570 feet per second, the pressure being 35,600 pounds per square inch. As this pressure exceeds the pressure prescribed for the gun, the charge of French B. N. smokeless powder was reduced from 18.75 pounds to 18.5 pounds, by which the pressure was reduced to about 33,000 pounds per square inch and the velocity to 2,537 feet per second. As respects accuracy, at 1-mile range the mean vertical deviation from center of impact was 2.3 feet, the mean horizontal deviation 1.88 feet, and the mean deviation, 2.99 feet. The number of rounds fired in three minutes was 19, of which 8 were fired in the first minute, the gun being served by two officers and five men. The officers operated the block and fired the gun; four men served ammunition and inserted the cartridges, and one man took charge of the empty cases. The rapidity was noticeably affected by the lack of power in the extractor, the fact that it was necessary to push the projectile well up into the rifling in order to close the block making the latter part of the block's motion somewhat difficult; by the necessity of keeping the block open to its fullest extent during the insertion of the cartridge, and by the care required before pulling the lanyard to insure that the officer operating the block was out of the way.

In the dust or sand test the breech mechanism was as far as possible filled with sand forced in by the action of a blacksmith's bellows. To open the block it was necessary to disconnect the extractor from it. The block was dismounted from the slot, and the dust brushed off, the chamber and bore wiped out with the gun sponge, and the sponge used to brush the dust out of the breech threads and extractor guide. Total time required for these operations and to fire five rounds, forty-one minutes and forty-four seconds. But one defective cartridge was fired. Before this test the gun was thoroughly cleaned and oiled. The case was prepared by filing four slots obliquely through the edge of the rim at an angle of about 40 degrees with the axis, so as to just touch the cavity of the case. Upon discharge a large quantity of gas escaped through the block, being blown about 100 feet to the rear. The console was unlatched and the block slightly rotated. The block could not be opened by hand, but required blows on the lever by mallet to rotate it. After rotation the block was withdrawn by blows from the muzzle with a rammer. The claw of the extractor was found broken off, rendering the latter unserviceable.

For combined accuracy and rapidity, a single target of ten rounds was taken at 1 mile, resulting as follows: Mean vertical deviation from center of impact, 1.85 feet; mean horizontal deviation, 2.05 feet, and mean deviation from center of impact, 2.76 feet. Time of firing, four minutes and eight seconds.

The "blow-back" or defective primer test was made by thinning the metal of the primers sufficiently to insure that the primer would break at discharge and allow the gases to penetrate into the mechanism. One round was fired, resulting in the blowing out of the firing pin and the twisting and bending of the firing-pin spring. These parts had to be renewed before firing could be continued.

Under the test for excessive pressure, pressures of 42,000, 50,286, and 53,489 pounds per square inch were obtained. No accident of any kind occurred during this test.

The work of the carriage throughout the firing was satisfactory.

Canét 12-centimeter (4.72-inch) rapid-fire gun.—This gun is a built-up steel gun, weighing 5,830 pounds, and has a length of 40 calibers. It is fitted with the regular Canét breech mechanism, and is mounted on a spring-return limited-recoil mount, Bellville springs instead of spiral springs being employed for returning the piece to the firing position. The recoil is checked by means of a hydraulic cylinder. A full description of the gun and mount is contained in the report of the Ordnance Board, which forms an appendix to this report. The ammunition consists of a solid drawn brass case having a primer which may be secured into its seat immediately prior to firing and thus reduce the liability to accident. The weight of the projectile is 46.2 pounds, and the powder charge is 11 pounds of B. N. smokeless powder.

The regular programme was followed in the test of this gun up to the time that it was permanently disabled. The action of the breech mechanism in manipulation and deliberate firing was satisfactory. The number of parts of the mechanism is 39, including four springs. This number, though not excessive, is considered greater than is consistent with the simplicity and certainty of action required in a rapid-fire gun. The extractor has little surplus power over that required under normal conditions, and a separate tool is provided for the extraction of cases which have stuck in the chamber. This feature results in a tendency to overstrain and therefore bend and distort the extractor before it is discovered that use must be made of this tool. The action of the extractor under normal conditions is simply to loosen the case, after which the latter is withdrawn by hand. At the termination of the operation of closing the breech the right arm of the operator, as well as a considerable portion of his body, is in rear of the breech of the gun. As already stated, this is considered by the board a very objectionable feature in a rapid-fire gun, as it might easily happen in the excitement of rapid firing that the piece would be discharged after the block is closed but before the operator has time to get out of the way, which might result in his being seriously injured by a blow due to the recoil of the piece. A safety pin is provided to guard against premature explosion. The three motions of rotating, withdrawing, and swinging the block are accomplished by a single motion of the lever, an arrangement which adds considerably to the complexity and number of parts of the system.

With a charge of 10 pounds 8 ounces B. N. smokeless powder a velocity of 2,131 feet per second, with a pressure of 34,200 pounds per square inch, was obtained in January, 1895, but later on this same powder had undergone so considerable a change that a very much higher pressure and a higher velocity were developed with even a less charge of powder. By substituting cordite for B. N. powder, and using a charge of 8 pounds 4 ounces, a mean velocity of 2,470 feet was obtained, with a pressure of 34,000 pounds.

In the test for rapidity the charge was, for safety, reduced. The gun's detachment consisted of two officers and five enlisted men, one officer operating the breechblock and the other pointing and firing the gun. At the end of the first minute four rounds had been fired; at the end of the second nine rounds, and at the end of the third minute eighteen rounds had been fired. Two missfires were counted as fired rounds. The missfires affected the rapidity to the extent of one or possibly two rounds. They appeared to be due to the insensitive primers rather than to lack of strength in the firing mechanism.

With a charge of cordite, targets were taken at 1 mile and at 3,000 yards. At 1 mile the mean vertical deviation from center of impact was 2.34; mean horizontal deviation, 1.77 feet; mean deviation, 2.94 feet. At 3,000 yards the mean vertical deviation was 3.8; mean horizontal deviation, 3.82, and mean deviation, 5.42.

In the test for rapidity with accuracy, the firing was made, for safety, with reduced charges. The results were as follows at 1,000 yards: Mean vertical deviation from center of impact, 1.55 feet; mean horizontal deviation, 1.34 feet, and mean deviation, 2.05 feet. Time for 10 rounds, one minute fifty-nine and one-half seconds. At 500 yards the results were as follows: Mean vertical deviation, 0.86, mean horizontal deviation, 0.83, and mean deviation, 1.20 feet. Time for ten rounds, one minute and fifty-five seconds, excluding a delay of seven minutes and twenty seconds caused by a missfire. These short ranges were used because of the small charge and the consequent reduction in velocity.

In firing for rapidity with accuracy, alternating at two 500-yard targets, 75 feet apart, this gun became permanently disabled by the blowing out of the breechblock. The gun was aimed and the firing conducted by the same officer who had conducted all the rapidity and accuracy tests made with the gun. Prior to this round, on account of the missfires which had occurred, the firing pin, which had become somewhat burred on its edges and fitted rather loosely on its seat, was replaced by a new pin. At the second round, while the man who was in charge of the mechanism was in the act of closing the block, a premature explosion occurred, resulting in the blowing out of the breechblock and the disabling of the gun. This premature explosion, it appears from the reports, was caused by the faulty seating of the coned portion of the firing pin in its recess, and, although the firing pin was somewhat shorter than that previously used, this faulty adjustment of the two coned surfaces caused the pin to protrude to a dangerous extent beyond the face of the breechblock, so that when the latter was entirely closed, as in the rapidity test, the protruded pin was enabled to strike the primer a blow sufficient to explode the cartridge before the block was fully closed. The difference in the amount of protrusion was slight, but it was sufficient to determine the difference between absolute safety and extreme danger. The breech mechanism having been completely destroyed by this accident, the test of the gun and mount was closed.

The action of the mount during the test was satisfactory.

Hotchkiss 12-centimeter (4.72-inch) rapid-fire gun.—This gun is a built-up steel gun weighing 4,370 pounds, and is of 40 calibers total length. It has the usual Hotchkiss breech mechanism—falling-block system—and is mounted on a limited recoil mount with hydraulic cylinders for checking the recoil and springs for returning the piece to the firing position. A full description of the piece and its mount will be found in the report of the Ordnance Board, which forms an appendix to this report.

In testing the piece in accordance with the prescribed programme, a charge of 10 pounds French smokeless B. N. powder, with a 55 pound projectile, gave a velocity of about 1,883 feet per second and a pressure of 24,390 pounds per square inch. With a projectile weighing 36 pounds 4 ounces the velocity was about 2,048 feet. The action of the breech mechanism during these rounds resulted in nothing worthy of note, except that the weight of the breechblock was found to be a serious hindrance to its quick and easy manipulation in closing.

In the test for rapidity, 10 pounds of B. N. smokeless powder and a projectile weighing 36 pounds 4 ounces were used. The number of rounds fired in a minute was seven. On account of the slow combustion of the powder, large quantities of flame rushed out of the breech of the gun each time that the block was opened. It was therefore found necessary to suspend the firings after one minute and twelve seconds, eight rounds having been fired in this time. In order to obtain a more suitable powder for this test, I. B. E. sphero-hexagonal powder was employed, this being a powder procured for the 5-inch siege gun. With this I. B. E. powder, the mean pressure of four rounds, the charge being 15 pounds, was 36,750 pounds. This powder was accordingly selected, and the charge placed at 15 pounds. At the first round, using this charge of powder indications of a higher pressure were observed. The cartridge case stuck in the bore and was backed out with difficulty by means of a rammer passed in from the muzzle. The head of the case was slightly distorted, and gas escaped from one of the rivets securing it. The case was not split.

A second round was then fired, and the same indications, though to a less degree, were observed; there was no escape of gas past the rivets. As the indications pointed to high though not abnormal pressures, it was decided, for safety, to postpone the test for rapidity and to take additional pressures. To this end, a case was unloaded, a pressure plug placed in the bottom, and the charge and projectile replaced. At this point the gun burst. The projectile and breech projected about 100 yards to the rear; the pressure plug was not recovered. The body of the cartridge case remained in the gun. The head was blown off and to the left. In loading the cases the powder was placed in a bag, and a careful investigation was made to ascertain the cause of this disaster, if possible. The gun was star-gauged, and the results showed no abnormal change. The appearance of the freshly fractured surfaces indicated good metal, and specimens were subsequently taken from the fragments and tested at the Watertown Arsenal, and this test also showed that the metal was of good quality.

In order to determine the pressures exercised by the powder charge, another rapid-fire gun of the same caliber and volume of chamber was employed, in which charges were used greatly increasing up to 13½ pounds, with a projectile weighing 36½ pounds. The maximum pressure obtained with the latter charge was 38,200 pounds per square inch. It was intended to carry the charge up to 15 pounds, but owing to defects in the breechblock developed by the firings, the gun was withdrawn for repairs, and it has not up to this date again become available for firing. The results are sufficient, however, to indicate that a charge of 13½ pounds was sufficient to produce the standard pressure, and that the charge selected for the rapidity test was a pound and a half too great. Taking the highest pressure recorded in the 13½-pound charge—38,200 pounds per square inch—the pressure in the same gun with 15 pounds of the same powder, calculated by Sarrau's formula, is 44,740 pounds. This formula has by frequent use been proved to be very reliable, especially for this class of powder and for charges differing by small amounts. From all the indications and data obtainable, therefore, it appears that the pressure at the time of the rupture could not have exceeded 50,000 pounds per square inch, and this pressure is not sufficient to produce rupture of a gun properly designed and built.

The area of the cross section of the chamber is about 23 square inches and that of the fractured surface about 80 square inches; a pressure of 50,000 pounds in the bore would therefore produce a strain at the fractured surface of 18,750 pounds per square inch. To produce a strain at this surface of 44,000 pounds the elastic limit of the material would require powder pressure of 117,000 pounds per square inch, and for a strain of 89,000 pounds per square inch, the tensile strength of the steel, a powder pressure of 237,000 pounds per square inch. These figures indicate that the cause of the failure was not the lack of sectional area of metal at the place of fracture. As to the possibility of a defect in the manufacture, an examination of the gun after the accident showed a projection of the tube at the rear of about one-hundredth of an inch. This projection was not noticed before the accident, and it is probable that in manufacture the ends of the jacket and tube were faced off even. The constraint evidenced by this projection may have produced local strains tending to start a fracture, but nothing more than mere conjecture can be advanced in regard to the cause of this accident.

Armstrong 12-centimeter rapid-fire gun.—This gun is also a built-up steel gun of 4,676 pounds weight and about 41 calibers total length. The breechblock is on the Ellswick system, being formed in two steps, the front step being conical and the rear step cylindrical. Both steps have three portions of their threads removed, each corresponding to one-sixth of a turn of the block, and having the threads of one portion opposite the blank spaces on the other. The carriage is the balanced pillar mount, having hydraulic cylinders for checking the recoil and springs for returning it to the firing position. A full description of the gun and mount is contained in the report of the Ordnance Board, which forms an appendix to this report. The ammunition is metallic, but not fixed, the projectile and powder charge being separate. The cartridge case has a pronounced conical shape, and is of solid drawn brass, provided with a screw hole in its head for the electric primer and a cap to cover its mouth. The powder charge is about 5½ pounds of cordite; the projectile weighs 45 pounds. The velocity obtained was 2,204 feet per second, and the pressure 32,000 pounds per square inch.

Six rounds were fired, two with a charge of 5 pounds 8 ounces, one with 5 pounds 12 ounces, and three with a charge of 6 pounds of cordite. The mean pressure in the last three rounds was 36,000 pounds. At the sixth round, the primer being defective, a blow-back occurred, so injuring the mechanism as to render the gun unserviceable. The firing mechanism was completely disabled, the firing pin, insulator, and brass covering being permanently driven back about half an inch. The mainspring was upset and rendered useless. The breechblock could only be started after repeated blows on the end of the locking hammer. An examination of the mechanism showed that the only outlet provided for the gases resulting from a blow-back was to the rear through the mainspring recess in the carrier, thence through a few small holes bored in the bushing screwed into the rear end of this recess. This proved to be entirely inadequate, since, in addition to the fact that these holes were too small, they were effectively covered by the flat end of the mainspring. The gases, therefore, finding no egress, exerted their pressure on the entire front surface of the carrier, and the blow thus produced was transmitted by means of the rotating stud to the breechblock. As the gun could not be again fired without extensive repairs and alterations, and as other systems of more recent design and less complexity of parts would be available in the near future, the board decided to suspend for the present the further test of this system.

The action of the mount throughout the firings was satisfactory. It is strong and simple in construction, and is easily and quickly manipulated. The balance pillar feature is especially worthy of consideration. By its use the gun may be habitually retained concealed behind the parapet, from which position it can be raised and prepared for action in twenty seconds. In the same time it can be lowered and put under cover, to be there retained until required for service.

Driggs-Schroeder 4-inch rapid-fire gun.—The weight of this gun is 3,500 pounds, and its total length is 41 calibers. The breech mechanism is the Driggs-Schroeder falling-block system. This gun was submitted to only a partial test. In the preliminary firing the action of the mechanism in deliberate firing was very satisfactory. All the parts of the mechanism are securely housed and protected from the weather. The breechblock is light for the caliber, and its manipulation was easy and certain. The block under normal conditions has no tendency to fly open, and if a cartridge becomes stuck in the chamber the mechanism can be easily dismounted and the case driven out from the front. The cartridge can be pushed home by the block in closing when it is at a distance of 3½ inches from the seat.

This operation is attended by no danger whatever of a premature explosion due to a protruding firing pin, as the movement of the block is such that the protruding pin can not be brought into contact with the primer until the block is closed and locked. Moreover, the chances of a protruding firing pin are reduced to a minimum in this system, as the pin is always retracted to within the limits of the block before the latter can descend, and is therefore protected from danger of becoming broken or bent and wedged in its seat. The gun can not be fired until the breech is closed and locked, as up to the completion of this motion the arm of the cocking cam is interposed sufficiently to prevent this firing pin from striking the cap. The position of the man who aims and fires the gun, as well as of the one who manipulates the block, is on the side of the gun, well forward of the breech. No portion of the body of the man working the block is at any time during the firing required to be in the rear of the gun. This is considered by the board a very important and valuable feature of this system. In the preliminary firings the charge corresponding to the standard pressures for the gun was determined to be 9 pounds of Q. B. E. sphero-hexagonal powder; and 10 pounds of W. A. and W. F. brown prismatic powder was fixed as a safe charge for the rapidity test.

In the rapidity test the total time for 25 rounds was two minutes and thirty-four seconds. The first 21 rounds were fired smoothly, and without delays from sticking of cases, in exactly two minutes, and although the firing was conducted under adverse circumstances, the direction of the wind causing smoke to blow in the faces of the gunners, this time may be considered as fairly representative of the rapidity of the gun.

In the dust test the mechanism was subjected to a blast of sand for eight minutes. The breechblock was then removed without difficulty; the sand and dust were removed from the mechanism by hand and from the chamber by a sponge. The gun was then loaded and fired. The total time required was one minute and fifteen seconds.

The gun was fired five rounds with increasing pressures up to 47,000 pounds per square inch. The mechanism worked well throughout the test.

In the defective-cartridge test, upon firing the first defective case the gas escaped into the mechanism, drying up the oil and covering the mechanism with residue. The block worked stiffly, on account of lack of lubrication. In other respects the gun received no injury. In firing the second case, the block was found partially opened, the operating handle having made about a quarter of a turn. The block could not be opened by hand, and could only be turned by blows of a sledge hammer. The locking spring, right extractor, and sear were broken. The firing pin could be locked, but owing to the displacement of the cam, so that the shoulder ceased to bear against the firing pin, the latter could be fired in any position. The outer portion of the main bolt was broken within half an inch of the exterior surface of the jacket, and as the remainder of the bolt could not be removed by the hammer, it was drilled out, and was then found to be in three pieces. The broken parts having been replaced, the gun was fired three rounds to test the working of the mechanism, and was then subjected to the test by blow-backs. Three rounds were fired. The mechanism received no injury except that due to fouling, and the block worked easily after each round.

For the rust test the breech of the gun was immersed in a solution of 15 per cent sal ammoniac for twenty-five minutes, after which the gun was allowed to remain in a horizontal position for forty-eight hours, and was then replaced in its mount. The breechblock was then opened in twenty seconds, the guide bolts and firing pin were oiled, the wooden plug which closed the chamber removed by a rammer from the front, a primed empty case inserted, and the breechblock closed. The total time required to penetrate the block, perform the above operations, and to fire the primer was forty-one seconds. Three service rounds were then fired without difficulty. The mechanism having then been dismounted, all the parts were found well rusted.

As some doubt existed as to whether under normal conditions any portion of the pressure on the block could be transmitted to the main bolt, the latter was replaced by a wooden bolt of the same dimensions. The bearing surfaces on the block and jacket were well cleaned and dried, in order to utilize as much friction as possible. Two rounds were fired, with half and full charges, respectively; the bearing surfaces were then thoroughly lubricated to diminish friction, and the two rounds were repeated; the wooden bolt remained uninjured.

As a result of all the tests, the board is of the opinion that the 4-inch Driggs-Schroeder mechanism has shown itself to be simple, safe, and efficient for a rapid-fire gun of this caliber. It was not practicable to make a more exhaustive test as to endurance of this gun, but the Department has now under manufacture a 5-inch gun fitted with this breech mechanism, which will be thoroughly tested for endurance.

Rapid-fire guns for service.—The fortifications act of June 6, 1896, contains an item of appropriation of $150,000 for the purchase of rapid-fire guns for service. Under this provision a contract has been made with the American Ordnance Company for ten 6-pounder rapid-fire guns with their mounts and 250 rounds of ammunition per gun. The breech mechanism is of the Driggs-Schroeder type. The mount is a rampart carriage that will admit of being fired over a 4-foot parapet, and also of being used in the open for firing upon landing parties. It is fitted with hydraulic recoil cylinders, and for short distances will be hauled by hand. For longer distances a limber will be employed. Two ammunition chests are carried upon the axle of the carriage.

A type 5-inch rapid-fire gun fitted with the Driggs-Schroeder breech mechanism is now under manufacture at the Army Gun Factory, and another type, which is to be made from a single forging and the initial strains secured by means of interior cooling, has also been placed under contract at the Bethlehem Iron Works, who are to supply the forging and apply the necessary treatment to secure the desired initial strains. This gun is to be fitted with the Fletcher breech mechanism.

Should this method of constructing such guns prove successful, it is expected that it will result in a considerable reduction in the cost of the arm, since a large number of them will be required for the complete project for seacoast defense.

These guns will be ready for trial in the course of a few months. A balanced pillar mount is also under construction, and will be tested at the same time with the guns. On the completion of the trial of these guns an additional lot of some eight guns will be procured, with their mounts and about 100 rounds of ammunition per gun, from the money available under the existing appropriations.

STEEL PROJECTILES FOR SEACOAST SERVICE.

Under the provisions of the last fortifications act, a contract has been made with the Midvale Steel Company for 225 10-inch armor-piercing shot, small core, 115 8-inch armor-piercing shot, large core, 205 10-inch armor-piercing shot, large core, and 100 12-inch armor-piercing shot, large core. These projectiles, with those already on hand, will provide about seven projectiles for each 8-inch gun, twelve for each 10-inch gun, and eight for each 12-inch gun that will be completed by June 30, 1898.

The Department has also made a contract with the Midvale Steel Company for 375 12-inch deck-piercing shell of 800 pounds weight, 105 12-inch deck-piercing shell of 1,000 pounds weight, 247 12-inch torpedo shell of 800 pounds weight, and 247 12-inch torpedo shell of 1,000 pounds weight. These will provide about eight and one-half deck-piercing shell and three and one-half torpedo shell for each of the 144 mortars that will be completed by June 30, 1898. The question of the proper bursting charge for mortar shell is still under experimentation. Gun cotton, emmensite, and other explosives are on trial.

Emmensite is a more powerful explosive than gun cotton when the two are used in equal volumes, but it is a question whether explosion of emmensite on impact can be properly controlled so as to insure penetration before rupture of the shell. There will probably be no difficulty in firing it with ordinary charges from high-power guns, but that is only one requirement, the other being, as indicated above, the necessity for obtaining penetration before explosion of the bursting charge occurs.

PNEUMATIC DYNAMITE GUNS.

The battery of three 15-inch guns at Fort Winfield Scott, Cal., to be erected under the contract of January 27, 1893, with the Pneumatic Torpedo and Construction Company, was completed, in readiness for military use, in October last. A trial of the battery, before its acceptance by the Department, was made by a board of officers whose report is appended. The guns passed the test prescribed for their acceptance, and the battery has been placed at the disposition of the troops at the Presidio for instruction and drill.

Penthouses made of wood, in parts that can be easily set up or taken apart, have been provided for the protection of the guns in this battery and in the one at Sandy Hook.

LEWIS RANGE AND POSITION FINDER.

This range finder, upon the recommendation of the Board of Ordnance and Fortification, approved by the Secretary of War February 8, 1896, has been adopted for service.

Three of the instruments have been purchased and issued to posts for trial in service as follows: One at Fort Monroe, Va., for height of station between 30 and 100 feet; one at Fort Adams, R. I., for height of station between 75 and 250 feet; and one at Fort Winfield Scott, Cal., for height of station between 200 and 400 feet.

Before issuing the Fort Monroe instrument, it was set up at the Sandy Hook Proving Ground and used by the Ordnance Board for the purpose of preparing instructions for the installation, care, and preservation of the range finders. These instructions, together with a description and photographic plates of the instrument, were furnished in full to the posts to which the three instruments were issued. The instructions so given relate to the use of the instrument for its one position alone, and do not include the methods of communicating the information obtained with the instrument to a gun or battery situated at a distant point. They will necessarily, therefore, be supplemented hereafter by instructions resulting from knowledge gained by the use of the position finder as a unit of the system of which it is intended to form a part.

Other less expensive range finders are under investigation.

FIELD AND SIEGE ARTILLERY.

By the last fortifications act sufficient funds were appropriated to procure ten additional 5-inch B. L. siege rifles, with their carriages; ten 7-inch B. L. siege howitzers, with their carriages; twenty 7-inch B. L. siege mortars, with carriages and platforms; fifty 3.2-inch field guns, with their carriages, and twenty 3.6-inch B. L. field mortars, with their carriages and platforms. Advertisements have been issued for the forgings for these guns, but contracts for their purchase have not yet been made.

Out of the funds appropriated for projectiles for service in the fortifications act of June 6, 1896, 4,000 3.2-inch 16.5-pound shrapnel will be procured from the American Ordnance Company, under a contract made September 4, 1896. In addition, orders have been placed at the Frankford Arsenal for the manufacture of 2,000 of the same shrapnel, and 1,000 3.6-inch 20-pound shrapnel, with fuses for the whole number.

All the cases for fixed ammunition for 3.2-inch field gun made during the year are of brass, solid drawn. The trials of cases made of aluminum alloy were suspended in December last, after repeated unsuccessful trials of cases made of different alloys of aluminum, including alloys with 2 and 5 per cent of copper. These experiments will be resumed when a metal promising success is discovered.

A rack press designed at Frankford Arsenal for assembling the projectiles and cases of 3.2-inch fixed ammunition is described in an appended report.

A range table for the 3.6-inch B. L. rifle with common shell and shrapnel has been prepared, and is appended hereto with the report of the firing tests made at the Proving Ground upon which the tables are based. The tables are not carried beyond a range of 4,500 yards, which probably exceeds the useful limit for field operations, due to inaccuracy of view and the necessity for observing the effect of shot. The range of 4,500 yards, with shell, is reached with an angle of 10° elevation.

The friction primers for cannon with axial vent have been rendered more effective by improvements made in their construction during the year, chiefly as regards the strength of connection between the parts.

From trials made at the Sandy Hook Proving Ground in March last with the service pattern (Sawyer) canister for 3.2-inch field gun, it was ascertained that for two rounds fired the mean horizontal angle of dispersion is 6° 33′, and the mean vertical angle of dispersion 5° 55′. At 50 yards range the number of hits on target, 26 feet wide by 18 feet high, was 197 and 207. At this range all bullets passed through 4 inches of spruce; when the thickness was increased to 5 inches, about 67 per cent passed through. The canister contains 224 round balls of cast iron, 0.625 inch diameter, and each weighing about one-half ounce.

The Frankford Arsenal combination fuse (fifteen seconds) for shrapnel and base percussion fuse for shell, recently introduced in service, have been severely tested in transportation in field ammunition chests with safety. The following extract from letter of Capt. S. W. Taylor, Fourth Artillery, recites the trial of ten of each of these fuses sent to Fort Leavenworth:

> On the 5th of November, 1894, the shrapnel and shell (with bursting charge removed) were put in the rear chests of caissons, five in each chest, and were left in there until September 4, 1895. During the time that they have been in the chests the battery has traveled 573 miles, at the walk, trot, and gallop, over rough, stony roads, up and down steep hills, over ditches, and across fords.

The fuses in this trial were complete in all respects, and no one of them was ignited. Their subsequent examination at Frankford Arsenal, when turned in after the trial, led to two minor changes, whereby the construction could be improved. One, to so arrange the base plunger as to make it immaterial which end is inserted in assembling the fuse, to avoid possible danger from the fuse being taken apart and reassembled for use by inexperienced hands; and the other a change in the size of the orifices through the primer to better confine the charge of powder in the central cavity of the fuse.

The patterns of 5 and 7 inch shrapnel, which have been tested and established as samples for manufacture in quantity as may be hereafter required, are 47 and 125.5 pounds in weight. They differ from the field shrapnel in having a central tube containing a part of the bursting charge, instead of having the whole charge in the head of shrapnel. The firing tests showed that the effectiveness of the larger calibers of shrapnel was increased by this distribution of the bursting charge. When exploded under cover, the 5-inch shrapnel was burst into 316 fragments, exclusive of lead balls, and adding the balls, 280, the total number of fragments was 596. Similarly for the 7-inch shrapnel, the total number of fragments was 1,086, including 449 balls, which in this shrapnel weigh each one ounce.

CHANGES IN MATERIAL.

Barrack cleaning rod.—Cleaning rods made of brass in one piece, with looped head, are now being issued for use with the .30-caliber magazine rifle and carbine. These rods are more efficient and better adapted for the purpose than the ramrod of the arms; the latter can, however, be used in the field and when the barrack cleaning rod is not accessible.

Breech covers for .30-caliber magazine rifle.—Several reports have been received from officers in the field suggesting the need of a breech cover to protect the breech mechanism of the rifle. Difficulty was found from the formation of ice about the bolt when exposed to wet in very cold weather, and from the accumulation of dust in the mechanism in practice marches through dry, dusty country. Other reports have been received from the field, stating the serviceability of the rifle under similar trying circumstances, and the manner in which the arm has withstood the severe rust and dust test to which it has been subjected serves to render doubtful the necessity of a cover, particularly if a certain amount of care were exercised by the soldier to protect his rifle by improvised means in case of extreme exposure. The attachment of a fixed cover to the rifle is not deemed advisable, but the objections to a light, removable cover, to be used only occasionally, and which can be readily carried on the person of the soldier, are not serious. In this view 1,000 light flexible covers of enameled cloth, of a size sufficient to envelop the breech mechanism only, have been issued for trial in service. Issues were made early in the season to fifteen companies of infantry, one or more in each military department, to be tried particularly on practice marches, and to be reported upon by January 1, 1897.

Carbine scabbards.—The issue of scabbards designed for the .30-caliber magazine carbine was begun in August last, and it is expected the entire cavalry service will be supplied by the end of October. These scabbards receive the entire forward portion of the carbine as far as the small of the stock. They afford much better protection and a more convenient mode of carrying than the boot. The scabbard can be slung on either side of the saddle, as may be determined upon after a short trial, and it is expected that the sling may be done away with as no longer necessary when the scabbard is used.

To test the question of the advisability of still further protection of the arm from dust and rain, a few scabbards were issued having leather flaps, which fit closely around the small of the stock when the carbine is sheathed, and completely cover the mouth of the scabbard.

Alteration of revolvers, caliber .38, model 1892.—The continued use of the Colt's double-acting revolver, model 1892, in service proved that the construction which admitted of operating the hammer without fully closing the cylinder was a source of trouble, and might render revolvers unserviceable. This construction has been remedied in the model 1894 revolver, and steps have been taken to recall the revolvers of model 1892 from service and replace them by those of model 1894. This exchange has been accomplished for the cavalry, except the Eighth, Ninth, and Tenth regiments. When the revolvers of model 1892 that have been turned in are altered to model 1894, the exchange will be completed throughout the service.

A pamphlet description of the Colt's double-acting revolver, model 1894, has been prepared and published by the Department for the information and use of the Army.

Paints for projectiles.—Asphaltum varnish has been found to be a more suitable material for coating the interior of projectiles made to contain a bursting charge of powder than the "lacquer for interior of shell," heretofore prescribed and published in Appendix 39 of the last annual report. The instructions regarding paints for projectiles have accordingly been revised and reprinted in separate form under date of August 6, 1896.

Ammunition for 3-inch M. L. wrought-iron rifle.—The issue of projectiles for the service of this piece has been restricted to shot, shell and case shot of Eureka, Absterdam (brass sabot), and Hotchkiss patterns, and canister of Sawyer and Hotchkiss patterns. The several styles of old percussion fuses have been withdrawn to give place to the F. A. point percussion fuse N, model 1894, with which all percussion shell to be issued will be fitted. Correspondence has been held with the governors of the several States and Territories to notify them of this change, and in cases where it was found that the militia was armed with the 3-inch muzzle-loading rifles all the percussion shell previously issued to them by the Department were recalled and replaced by shell fitted with the new percussion fuse.

3.6-inch field mortar.—In the construction of new mortars it has been decided to replace the front sight, which terminates in a knife-edge at top, by one having a pointed top, in order to facilitate the repair of front sights which may be damaged in service. The pointed sight can be assembled at any place and will hereafter be exclusively issued. In new constructions also the iron side-piece straps of the platform for this mortar will be countersunk to be flush with the top surface of the platform, as it was found that the projection heretofore existing interfered with the training of the piece and carriage. In the reduced charges used in this piece variations in the weight of the charge and in its position in the chamber when loaded will materially affect the accuracy. The charges to be used are carefully weighed before issue, and are now made up into cartridges of disk form which fit closely in the chamber of the piece and can be placed in a uniform position for each discharge.

Pasteboard boxes for .30-caliber ball cartridges.—The box, containing, as heretofore, 20 cartridges, has been modified in construction to adapt it for use with the Bruce feed on the Gatling gun. The string, which was formerly placed so as to facilitate lifting the cover of the box, is now arranged for tearing out an end of the cover, so that the latter may be slid off and not lifted from its place, to obviate displacement of the cartridges. The "comb" and "packing" of the box are held in place by muslin strips glued at the ends of the comb. The design of the whole is to provide a strong box for general purposes, and one which, when opened and turned for feeding the Gatling gun, will leave the cartridges undisturbed in the box, with a clear space about the heads for entering the grooves of the feed guide.

I have the honor to submit herewith the following papers as appendices to this report:

Appendix A.—Report of action taken during the year ending June 30, 1896, under the provisions of the act approved March 3, 1881.

REPORTS FROM SPRINGFIELD ARMORY.

Appendix 1.—Report of principal operations.

Appendix 2.—Nomenclature and description of the Gatling gun, caliber .30 (7 plates).

Appendix 3.—Test of Winchester repeating shotgun, model 1893 (1 plate).

REPORTS FROM FRANKFORD ARSENAL.

Appendix 4.—Manufacture of .30-caliber ammunition (6 plates).

Appendix 5.—Report of chemical laboratory.

Appendix 6.—Test of Tweedie .30-caliber bullet (1 plate).

Appendix 7.—Description of Frankford Arsenal 3.2-inch and 3.6-inch shrapnel (4 plates).

Appendix 8.—Description of Frankford Arsenal 5-inch shrapnel (7 plates).

Appendix 9.—Description of Frankford Arsenal 7-inch shrapnel (7 plates).

Appendix 10.—Rack press for assembling 3.2-inch fixed ammunition (1 plate).

REPORTS FROM WATERVLIET ARSENAL AND ARMY GUN FACTORY.

Appendix 11.—Report of principal operations (7 plates).

Appendix 12.—Description of oil-gas furnace (2 plates).

REPORTS FROM WATERTOWN ARSENAL.

Appendix 13.—Report of principal operations.

REPORTS FROM ORDNANCE PROVING GROUND, SANDY HOOK, NEW JERSEY.

Appendix 14.—Report of principal operations.

Appendix 15.—Summary of tests of smokeless powders.

Appendix 16.—Range table for 3.6-inch B. L. field gun.

REPORTS FROM BENICIA ARSENAL.

Appendix 17.—Tests of charcoal and smokeless powders.

MANUFACTURE OF POWDERS.

Appendix 18.—Report of the inspector of powder.

CONSTRUCTION OF ORDNANCE.

Appendix 19.—Progress report of the inspector of ordnance on the manufacture of steel forgings, castings, etc., for guns and carriages at the Midvale Steel Works, Philadelphia, Pa.

Appendix 20.—Progress report of the inspector of ordnance on the manufacture of steel forgings, castings, etc., at the Bethlehem Iron Works, South Bethlehem, Pa.

REPORTS FROM ORDNANCE BOARD.

Appendix 21.—Trial of Armstrong 12-cm. (4.72-inch) rapid-fire gun and mount (8 plates).

Appendix 22.—Trial of Maxim-Nordenfelt .303-caliber automatic machine gun (10 plates).

Appendix 23.—Trial of Canét 12-cm. (4.72-inch) rapid-fire gun and mount (17 plates).

Appendix 24.—Trial of Driggs-Schroeder 4-inch rapid-fire gun.

Appendix 25.—Trial of Hotchkiss 12-cm. (4.72-inch) rapid-fire gun and mount (2 plates).

Appendix 26.—Trial of Schneider 12-cm. (4.72-inch) rapid-fire gun and mount (10 plates).

Appendix 27.—Progress report on trial of Crozier 10-inch wire-wound B. L. rifle (6 plates).

REPORTS OF BOARD FOR TESTING RIFLED CANNON, ETC.

Appendix 28.—Trial of 10-inch B. L. rifle, steel, type (2 plates).

Appendix 29.—Trial of Crozier 10-inch wire-wound B. L. rifle.

Appendix 30.—Trial of 12-inch B. L. rifle, steel, type (2 plates).

MISCELLANEOUS.

Appendix 31.—Report on the construction of a battery at Quonset Point, R. I. (3 plates).

Appendix 32.—Trial of pneumatic dynamite gun battery, Fort Winfield Scott, Cal.

Appendix 33.—Description of Lewis range and position finder (5 plates).

I have the honor to be, very respectfully,

D. W. FLAGLER,
Brigadier-General, Chief of Ordnance.

The SECRETARY OF WAR.

APPENDIX A.

Report of action taken under the act of March 3, 1881, during the fiscal year ended June 30, 1896.

April 28, 1896. Purchased from Laflin & Rand Powder Company, 50,734⅜ pounds of saluting powder for field guns, at 8 cents per pound $4,058.75

APPENDIX 1.

REPORT OF PRINCIPAL OPERATIONS AT SPRINGFIELD ARMORY DURING THE FISCAL YEAR ENDED JUNE 30, 1896.

SPRINGFIELD ARMORY,
Springfield, Mass., September 30, 1896.

SIR: I have the honor to submit the following report of the principal operations at this Armory during the fiscal year ending June 30, 1896:

BUILDINGS AND GROUNDS.

On the second new set of quarters for officers was expended the funds allotted toward their completion, but as the amount was only two-fifths of that estimated to be required, the quarters still remain in an unfinished state. The heating apparatus and hot-air pipes, the gas pipes, the wirings for electric light and for electric bells have been put in; the lathing has been done; the sash, blinds, doors, flooring, plumbing fixtures, and a portion of the inside finish have been purchased, and the building now awaits additional funds to enable the materials on hand to be used.

The two sets of quarters for noncommissioned officers referred to in the annual report of last year have been fitted up and occupied, the old frame building in rear of the hospital has been removed, and the small set of brick quarters, near this last, has been moved directly east and placed on a new foundation 50 feet west of the brick set that was moved the previous year.

The exteriors of the house last moved, of the hospital, and of the fire-engine house have been painted.

Federal street, owned by the United States, was macadamized from State street to Lincoln street, a distance of 925 feet, leaving that portion extending to Pearl street, 475 feet, to be rebuilt when the necessary funds may be appropriated.

The streets belonging to the United States and used as public highways by the city of Springfield are too extensive to be kept in order from the usual yearly appropriation, and as the city improves its streets, some attention is demanded by the Government to those owned by it. For this purpose, a special appropriation of a few thousand dollars is very desirable annually, till the property referred to may be put in as good order as the adjacent parts belonging to the city, and after that only an occasional expenditure would be needed to maintain the roadways and sidewalks.

MAGAZINE RIFLE AND CARBINE.

The magazine rifle now being fabricated is known as model 1896 and embodies the changes enumerated in the annual report of last year, with the exception of the modification then proposed for the cut-off. As this alteration was not found to operate invariably, it has not been introduced; recent experiments, however, promise that this change will be successfully accomplished.

The first magazine carbines were finished and issued on March 10, and the arming of the entire cavalry was completed by the last of May.

The defects due to the metal or to weakness of construction observed in the rifles issued have, it is believed, been overcome in the carbines and in the rifles made since.

There being no doubt in regard to the inaccuracies in the graduations on the rear sight of the rifle, as reported by the troops and observed at this Armory, several series of firings to determine more correct graduations were had.

The previous firings had not been continued sufficiently long at the different ranges to obtain accurate results, and even the deviation had been incorrectly given, since prolonged firing has proved that up to 500 yards there is practically no deviation whatever, and that between this and 1,000 yards, the deviation, which is slight, appears to be to the left instead of to the right; firings now being made will fully decide this.

Practice at the Armory in different months of the year, with varying temperatures, has proved, without doubt, that no sight with positive graduations is applicable to general use with the new powders; uniform results can not always be obtained with any fixed elevation for any range.

With the view of substituting a more useful and accurate sight for the one first issued with the rifles, there was submitted from this office in November a new pattern of leaf slide, in which a binding screw took the place of the spring catch; this enabled the slide to be fixed at any point along the leaf and permitted the soldier to adjust his sight for all ranges between 600 and 1,800 yards.

This recommendation was followed by a design for a curved sight base, such as was on the model 1879 sight, which offered provisions for the adjustment of the sight by the soldier for ranges below 700 yards. The notches in the leaf and slide were placed in the vertical plane containing the axis of the bore.

The reasons for the adoption of this new sight were set forth from this office as follows:

The elevation required varies with—

First. The initial velocity given by the ammunition when made, marked on each paper box.

Second. The uniformity of the cartridges in each paper box.

Third. The temperature of the ammunition, from the atmosphere, when the cartridge is fired.

Fourth. The temperature of the ammunition, from the gun, when the cartridge is fired.

Fifth. Irregularities in the manufacture of the arm, which apparently can not be prevented.

Sixth. Peculiarities belonging to the arm itself, which seem to be unaccountable.

Seventh. The kind of sight taken.

Eighth. The point of the target aimed at.

Ninth. The peculiarities of the individual, his vision, manner of holding the piece, etc., which each must discover for himself, and allow for accordingly.

Tenth. The condition of the atmosphere and light.

Eleventh. The heat of the barrel as affecting the air between the sights.

The long series of firings were made by two officers and two employees, the latter selected as excellent shots.

In one series six carbines were fitted with sights carefully adjusted to the arm, and the results below illustrate some of the points noted above. The elevation required by each arm at each range was measured after the best scores had been obtained.

No. of arm.	Range.	Elevation measured from axis.	No. of arm.	Range.	Elevation measured from axis.	No. of arm.	Range.	Elevation measured from axis.
	Yards.	*Inches.*		*Yards.*	*Inches.*		*Yards.*	*Inches.*
11803......	300	0.948	15787......	500	1.0365	15969......	700	1.166
11804......	300	0.946	15903......	500	1.021	21451......	700	1.204
15787......	300	0.9393	15969......	500	1.017	11803......	800	1.2485
15903......	300	0.942	21451......	500	1.0365	11804......	800	1.256
15969......	300	0.934	11803......	600	1.089	15787......	800	1.3028
21451......	300	0.9615	11804......	600	1.082	15903......	800	1.2398
11803......	400	0.987	15787......	600	1.089	15969......	800	1.243
11804......	400	0.9888	15903......	600	1.084	21451......	800	1.251
15787......	400	1.002	15969......	600	1.079	11803......	1,000	1.401
15903......	400	0.9962	21451......	600	1.0713	11804......	1,000	1.405
15969......	400	0.9052	11803......	700	1.2078	15787......	1,000	1.414
21451......	400	1.009	11804......	700	1.180	15903......	1,000	1.3955
11803......	500	1.035	15787......	700	1.215	15969......	1,000	1.3723
11804......	500	1.030	15903......	700	1.175	21451......	1,000	1.413

With an atmospheric temperature of 65° at 600 yards, the elevation for the carbine was found to be 1.07 inches, which gave good targets; when the temperature was 36°, using the same ammunition, carbine, and sight, the shots struck from 20 to 28 inches below the point aimed at. The elevation when adjusted was 1.089 inches, the difference corresponding to about 25 yards in range; when the temperature fell to 26°, the sight had to be altered to 1.093 inches, a change of about 30 yards in range.

With the sight now in use, the base formed in steps for 100 yards, from 300 to 600, it is not possible to make any adjustment closer than 100 yards, as for each step every point of contact between it and the leaf slide means the same elevation.

The slide with binding screw, just adopted, gives to the soldier the privilege of adjusting his sight between 600 yards and 1,900 yards, and the curved base extends the same opportunity below 600 yards.

The sight proposed is more simple in construction and in manufacture than the present one, and offers compensation for the inaccuracies arising from circumstances beyond control. This sight can not, like its predecessor, be set by feeling, but if the full graduations be clearly marked, much care will not be required in using them, and the means will still be furnished for as accurate adjustments as a marksman may desire.

Had such an arrangement as is now proposed been adopted and issued with the first rifles sent out, it is believed most of the complaints that have been made against the sight would have been avoided.

It is understood that with the sight model 1884, which has been so highly praised, the fixed graduations were seldom used, every soldier adjusting his leaf slide to suit himself and the conditions of his arm and ammunition.

It is still intended that the soldier shall learn to allow for "drift" and "wind," and, giving him elevations carefully determined under certain and most general conditions, to allow him to adjust his sight to compensate for those conditions which are variable and indeterminate. The proposition is to improve the sight without making it complicated, difficult to keep in order, or fine for target work, and the more accurate adjustment which it will permit is not that demanded alone for firing at targets at known distances, but that required in firing at estimated distances when the firer has sufficient head to observe his shots.

The proposed sight having been approved by you, its manufacture was commenced in January. Those for the carbines to be issued to the troops were first completed, and then the rifle sights were turned out at the rate of 200 per day and supplied to the organizations in service which had been furnished with the rifle. At this date the entire Army is equipped with the new sight.

Most of the injuries of any moment sustained by the magazine arms have occurred with the ammunition manufactured prior to the present cartridge with the solid head. These have been most frequent in the hot climates, and from Texas and Arizona have been reported by far the greater number of broken parts.

Of the effect of heat upon the smokeless powders in use there is no doubt; and the pressure obtained with the daily manufacture of cartridges at the factory is greatly increased by a hot climate, by the direct action of the sun, or by the heat of the barrel from repeated firing. The weak points in the arm developed by these high pressures have been corrected wherever known, and should be found not to exist in the newer arms, though all the parts can not be expected to resist abnormal strains that may arise from a possible defect in the ammunition.

The brass "barrack cleaning rod," approved in March and ordered to be issued to organizations at the rate of 1 to every 5 arms, is being supplied to the Army.

MANUFACTURE OF ARMS.

The changes made last year in the operations for the manufacture of the different parts have given very satisfactory results, and the new methods have been extended.

The most marked modifications, and consequent reduction in cost this year, have resulted from the introduction of some automatic drill presses, and of "face milling" as practiced by some other manufacturers.

The holes drilled to facilitate the removal of the metal of the receiver in forming the magazine are now made by the automatic machines, and the cost of this operation per receiver, which by the day was 25 cents, is now $3\frac{1}{10}$ cents.

The flat surfaces on the ejector, rear-sight slide, and cap are "face milled," and tools are being made to apply this method to the sides of the sear and trigger. The daily work of one machine on the ejector has been increased from 240 to 1,700, 21 cuts at one time, on the rear-sight slide from 450 to 1,600, 14 at one time, and on the slide cap from 450 to 1,350, 14 at one time; with the sears, 6 will be cut at a time, and with the trigger, 5.

In this method the pieces are placed in openings in plates or "leaves," which rest upon a bedplate, and the work is held down and cut by the milling tool, which bears upon it. The work turned out is excellent, but the cost may not in every instance be reduced, though a saving is always produced in machines and in shop room. With the ejector the cost of the cuts is one-third less than before, but with the other pieces not so much.

When the fixtures and gauges for the receiver were made, proper attention was not given to the "bedding surfaces" and the "gauging points." These features are in course of correction as the tools can be spared, and result in more accurate work.

The expenditure of lard oil for lubricating cutters has been so great that soda and water, with a small proportion of oil, has been substituted wherever possible, which is used on most of the profiling and milling machines. It has been in use on the former for several years, but not on the latter. The solution contained in tanks in the basement of the milling shop is pumped through pipes to each floor and drawn off at each machine in a constant stream upon the cutters; the fluid passes into a pail beneath each machine and flows off into pipes, through which it is returned to the tank, to be again pumped up. There are four tanks in use, containing a mixture in the proportion of 90 gallons water, 9 pounds sal soda, and 5 gallons lard oil; about half of this has to be replenished each month. The saving in cost will be known better at the end of the year.

The daily output of the Armory is now 120 magazine rifles or carbines; and as they are to be made in the proportion of 5 to 1, the shops will be run on carbines two months of each fiscal year; it is proposed to accomplish this by turning out carbines in the months of May, June, July, and August of every other calendar year.

The total number of operations on the rifle is 1,318, which includes those on duplicate pieces.

The question of possible expansion of the work of the Armory, when necessary, has been more fully considered, and the general conclusions were reported to you in March last.

The buildings used as shops are not occupied with machinery to their full capacity; with the machines and tools now in use, 125 arms can be turned out in a day of 8 hours.

The capacity of the buildings now occupied is taken at 200 arms per day, and to fit up for this number would cost about $68,000. To increase to 300 arms per day some of the old shops would have to be reoccupied, and to prepare the Armory for this output would, it is estimated, cost $252,000.

Without an extensive rearrangement of the buildings and plant at the water shops 320 arms per day of 8 hours can be turned out, and this can be considered the full capacity of the Armory for the present magazine arm. To expand to this number would cost about $265,000.

By working two gangs 10 hours each it would be practicable to manufacture 800 arms per day of 24 hours.

GATLING GUNS AND REVOLVERS.

The 13 long-barreled Gatling guns, caliber .30, with Bruce feed, contracted for by the Department January 16, 1895, were delivered by December 1, the contract having been extended to that date.

These guns are the best of the kind that have yet been made, and though there is room for improvement in some of the features of the gun, no better machine gun for small-arm cartridges has yet been presented in this country.

The 18 Gatling guns, model 1893, which have been ordered to be converted to model 1895 are now being altered at this Armory.

A full description of the model 1895 gun has been prepared and awaits the completion of the illustrations before being forwarded.

The Colt automatic gun has again been presented, and in accordance with your instructions has been thoroughly tested. The report of a board of officers, appointed at the Armory for the purpose, is submitted.

The 5,000 Colt's double-action revolvers, caliber .38, Army model 1894, contracted for April 23, 1895, have been delivered, after the usual inspection at the factory.

The revolvers, model 1892, are gradually being withdrawn from service for alteration to model 1894.

A single-action revolver, caliber .41, has recently been presented for examination and trial by the Colt's Company, and one by the Smith & Wesson Company; the test of these, which will be made shortly, may develop some points of value.

During the year no designs relating to magazine arms have been sented by inventors that called for examination and report under y instructions of January 3, 1893.

STEEL FOR GUN BARRELS.

The search for steel for barrels possessing higher physical propert and more uniformity in structure than that now in use has been c tinued during the year.

The highest properties obtained with a simple carbon steel whi gave good results in machining have been a tensile strength of ab 120,000 pounds and an elastic limit of 67,000 pounds. This metal co not be worked satisfactorily without being annealed, and from this t tensile strength was reduced to 98,000 pounds and the elastic limit 57,000 pounds—the results being below what are preferred in a barr

To avoid the injury to the properties due to annealing, numero experiments have been made with different methods of annealing, b not one has proved satisfactory.

When the bar was rolled into a barrel, the best results were obtaine if the piece was simply stood up in the shop and allowed to cool (spec men 49 A, Table II). These barrels, however, worked badly, man being too hard to drill or turn accurately.

The next best results were with the regular stock rolled by the manufacturer down to 1.1 inches diameter (specimen 57, Table II), cut to proper length, and worked without any heating whatever. To turn the cylindrical bar to the required taper called for additional lathes, time, and cost, and as the bars had not been annealed, but simply cooled, as ordinarily done in rolling mills, the drilling and turning were not performed without too great loss.

It appears essential that the carbon steels shall be annealed before they can be worked with certainty and accuracy in the machines used. This arises from the existence of hard spots and want of homogeneity in the metal, which are greatly diminished, if not eliminated, by annealing.

Some barrels of nickel steel—80, 81, 82, and 83, Table I—were submitted by the Bethlehem Iron Company; those (81 and 83) simply annealed did not give properties sufficiently high to recommend their trial; 3 barrels from each of 80 and 82, which had been oil tempered and annealed, have been completed and assembled in rifles, which are now being tested. Even if the results be most satisfactory, the working of this metal presents difficulties which will have to be overcome before such barrels can be generally used.

The material used in the barrels made during the year can, it is considered, be employed with safety, as several rifles tried have withstood repeated pressures of from 80,000 to 90,000 pounds; no undue enlargement of the chamber has occurred, and after several thousand rounds fired the wearing of the grooves has not been excessive, nor has the erosion from the powder been great.

Experiments with different steels and with different methods of treating and machining them are being continued. The results of the tests made during the year are embraced in Tables I and II, appended.

Respectfully, your obedient servant,

A. MORDECAI,
Colonel, Ordnance Department, U. S. A., Commanding.

The CHIEF OF ORDNANCE, UNITED STATES ARMY,
(10592—Enc. 5) *Washington, D. C.*

TABLE I.—*Samples of steel tested to determine those suitable for rifle barrels, caliber .30.*

No.	Date.	From whom.	Kind.	Designation.	Tenacity.	Elastic limit.	Elongation under maximum stress.	Elongation after rupture.	Contraction.	Broken surface.	Remarks.
	1895.				*Pounds.*	*Pounds.*	*Per ct.*	*Per ct.*	*Per ct.*		
80	Sept. 17	Bethlehem Iron Co.	Nickel-steel ingot No. 1, specially treated.	No. 45	103, 560	92, 000	11⅓	22	63. 7	Fine silky; serrated, cup-shaped ends.	3 barrels made for test.
81	....do	.....do	Nickel-steel ingot No. 1, simply annealed.	No. 46	87, 720	67, 000	13⅓	21⅔	47. 2	Silky; longitudinal cavity near axis.	
82	....do	.....do	Nickel-steel ingot No. 2, specially treated.	No. 47	103, 240	84, 000	11⅓	21⅔	65. 8	Fine silky; serrated, cup-shaped ends.	Do.
83	....do	.....do	Nickel-steel ingot No. 2, simply annealed.	No. 48	92, 000	58, 000	11⅔	21⅔	57	Fine silky; cup-shaped ends.	
84	....do	Spaulding & Jennings Co.	Bessemer steel	No. 49	114, 480	65, 000	11⅓	17⅔	33. 5	Silky, interspersed with fine granulation.	This stock used during the year.
85	Oct. 14	Atha & Illingworth Co.	Crucible steel	No. 50	103, 720	46, 000	10⅔	18	39. 2	Silky	
86	Oct. 22	Sanderson Bros. Steel Co.	.....do	No. 51	95, 160	59, 000	14	19	33. 5	Fine silky	
87	Dec. 7	.....do	.....do	No. 52	105, 440	68, 000	12⅔	13	15	Fine granular; dull silky center.	
88	Dec. 18	Midvale Steel Co.	Nickle crucible steel, oil tempered and annealed.	No. 53	120, 000	95, 000	8	17⅓	54. 6	Fine silky; cup-shaped ends.	
89	....do	.....do	.....do	No. 54	119, 680	93, 000	10	18⅓	54. 6		Bars contained seams.
	1896.										
90	Jan. 8	Sanderson Bros. Steel Co.	Crucible steel	No. 55	122, 000	60, 000	6⅓	9	11. 8	Fine granular; 2 small dull gray eccentric spots, 0.05 inch diameter.	
91	Mar. 17	.....do	Nickel crucible steel	No. 58–2	126, 320	68, 000	10⅔	13½	18. 3	Fine granular, radiating from a dull spot at circumference, where a punch mark defined first 1-inch section.	
92	....do	.....do	.....do	No. 59–3	141, 360	76, 000	9	9	11. 6		
93	July 29	Spaulding & Jennings Co.	Bessemer steel No. 49, rolled to 1.05 inches diameter.	No. 60	121, 950	77, 000	13	16⅔	43. 3	Very fine, silky	Bars too small for barrels.
94	....do	Midvale Steel Co.	Open-hearth steel	No. 61	106, 800	73, 000	14⅓	23⅔	49. 1	.....do	Does not possess sufficient firmness, stretches too much under proof, and does not give smooth surface when reamed.
95	....do	Spaulding & Jennings Co.	New, not known; bar 1.4 inches diameter.	No. 62	139, 900	79, 000	6⅔	15⅓	37. 1	Very fine, silky; cupped ends.	Additional samples to be furnished.

TABLE I.—*Samples of steel tested to determine those suitable for rifle barrels, caliber .30*—Continued.

No.	Date.	From whom.	Kind.	Designation.	Tenacity.	Elastic limit.	Elongation under maximum stress.	Elongation after rupture.	Contraction.	Broken surface.	Remarks.
	1896.				*Pounds.*	*Pounds.*	*Per ct.*	*Per ct.*	*Per ct.*		
96	July 29	Spaulding & Jennings Co.	Bessemer steel No. 49, rolled to bar 1.15 inches diameter.	No. 63	122,050	71,000	11	17⅛	40.3	Fine, silky; trace of granulation; cup-shaped ends.	To be tested.
97	....do	.....do	New, not known; bar 1.15 inches diameter.	No. 64	137,550	83,000	10	14	34	Fine, silky; interspersed with fine granulation; cupped ends.	Additional samples to be furnished.

TABLE II.—*Tests of rifle-barrel steel, subjected to different treatments after rolling.*

Date.	Treatment.	Marks.[a]	Sectional area.	Tenacity.	Elastic limit.	Elongation under maximum stress.	Elongation after rupture.	Contraction.	Appearance of fracture.
			Sq. inch.	*Pounds.*	*Pounds.*	*Per cent.*	*Per cent.*	*Per cent.*	
1896. Feb. 14	Regular stock; not treated	49	0.25	120,560	67,000	10⅔	16.7	44.6	Fine silky; cup-shaped ends.
		49	.20	113,300	70,000	11⅔	19.7	46.2	Fine silky.
	Rolled, reheated in gas furnace, and annealed in charcoal.	490 B	.20	109,400	59,000	11	19.3	30.7	Granular, 60 per cent; silky eccentric spots, 40 per cent.
		490 M	.20	114,500	65,000	13⅓	17.3	37.1	Fine silky.
	Rolled, reheated in gas furnace, and annealed in lime.	491 B	.20	115,600	69,000	13	16.7	40.3	Do.
		491 M	.20	118,100	75,000	12⅔	18.0	43.3	
	Rolled, reheated in open coke fire to light cherry color, and annealed in charcoal.	492 B	.20	124,000	61,000	9⅔	11.0	16.9	Fine granular, radiating from the center.
		492 M	.20	123,250	65,000	10	10.7	20.5	Fine granular, radiating from an eccentric spot.
	Rolled, reheated in open coke fire to light cherry color, and annealed in lime.	493 B	.20	127,300	67,000	9	10.7	20.5	Fine granular, radiating from a point near the center.
		493 M	.20	125,900	65,000	9⅔	11.0	16.9	Fine granular, radiating from a dull silky center.
	Rolled, reheated in gas furnace, annealed in charcoal, heated in open coke fire to light cherry color, and annealed in charcoal.	494 B	.20	112,250	64,000	12	17.7	34.0	Silky, interspersed with fine granulation.
		494 M	.20	112,850	65,000	11⅔	17.0	34.0	Silky, with a trace of granulation.
	Rolled, reheated in gas furnace, annealed in charcoal, heated in open coke fire to light cherry color, and annealed in lime.	495 B	.20	116,400	66,000	10⅔	15.0	30.7	Silky, interspersed with fine granulation.
		495 M	.20	112,100	69,000	6⅔	11.7	43.3	Exceedingly fine granular, radiating from a point near the center; cup-shaped ends.
	Rolled, annealed in charcoal, heated in open coke fire to light cherry color, and annealed in charcoal.	496 B	.20	119,800	65,000	11⅓	15.0	27.4	Silky, and fine granulation interspersed.
		496 M	.20	119,050	68,000	11⅓	17.7	30.7	
	Rolled, annealed in charcoal, heated in open coke fire to light cherry color, and annealed in lime.	497 B	.20	120,000	63,000	9⅔	13.3	27.4	Fine granular; dull silky eccentric spot.
		497 M	.20	123,100	69,000	11⅓	16.7	37.1	Silky, with trace of fine granulation.
	Rolled, annealed in air, heated in open coke fire to light cherry color, and annealed in charcoal.	498 B	.20	114,100	56,000	11	15.3	27.4	Granular, irregular surface; dull spot at the circumference.
		498 M	.20	118,200	60,000	11⅓	14.0	30.7	Fine granular; dull center.
	Rolled, annealed in air, heated in open coke fire to light cherry color, and annealed in lime.	499 B	.20	115,500	63,000	10⅓	13.7	30.7	Fine granular, 60 per cent; silky, 40 per cent.
		499 M	.20	115,250	71,000	11⅔	17.3	37.1	Fine silky; cup-shaped ends.
Mar. 10	Regular stock, recent manufacture; not treated	49	.25	104,720	64,000	13⅓	22.3	44.6	Silky; cup-shaped ends.
		49	.20	104,900	63,000	14	21.0	46.2	Silky.
	Stock heated and rolled to barrel, and annealed (cooled) in air.	49 A	.20	116,200	80,000	14	18.7	46.2	Silky; cup-shaped ends.
		49 A	.20	123,350	83,000	10⅔	17.7	46.2	

[a] B, breech; M, muzzle.

TABLE II.—*Tests of rifle-barrel steel, subjected to different treatments after rolling*—Continued.

Date.	Treatment.	Marks. *a*	Sectional area.	Tenacity.	Elastic limit.	Elongation under maximum stress.	Elongation after rupture.	Contraction.	Appearance of fracture.
			Sq. inch.	*Pounds.*	*Pounds.*	*Per cent.*	*Per cent.*	*Per cent.*	
1896. Mar. 10	Stock heated and rolled to barrel, and annealed in lime.	49 L	.20	112,050	74,000	12⅓	20.3	51.9	Silky; cup-shaped ends.
		49 L	.20	113,320	70,000	12⅔	18.7	43.3	
	Stock heated and rolled to barrel, and annealed in sand.	49 S	.20	110,900	70,000	11⅓	19.7	43.3	Do.
		49 S	.20	118,150	70,000	11⅓	18.0	40.3	
	Regular stock, rolled in bar 1.1 inches diameter, from which barrels made without heating.	57	.25	124,960	77,000	11	18.8	44.6	Do.
Apr. 11	Annealed in air-tight chest without any packing	49 P	.20	120,000	66,000	11	14.3	37.1	Silky; trace of granulation.
Apr. 14	Sample untreated	49	.25	120,480	69,000	11	17.3	39.2	Fine silky, with trace of granulation.
		49	.20	124,550	71,000	10	16.3	37.1	
	Rolled into barrel and cooled in air	49 A	.20	124,350	71,000	10	14.7	37.1	Silky, interspersed with fine granulation.
	Rolled, and annealed in charcoal	49 C	.20	118,000	67,000	11	16	34	Fine granulation; silky center.
May 26	Annealed in charcoal after rolling	49 B	.20	110,050	67,000	12⅔	19	34	Silky, interspersed with fine granulation.
		49 M	.20	122,400	69,000	11⅓	14.3	20.5	Fine granular, radiating from an eccentric spot.
Aug. 25	Samples from a barrel that had been rolled, cooled in air, reheated in coal furnace, and annealed in charcoal.	49 A. M. *b*	.20	107,550	58,000	12⅔	18.7	37.1	Silky, with trace of granulation.
		49 A. B. *c*	.20	106,350	57,000	11⅔	17.7	37.1	
July 29	Sample untreated	49	.20	120,600	67,000	12	17	40.3	Fine silky; trace of granulation.
	Rolled barrel, annealed in charcoal	49 A	.20	98,600	57,000	13⅓	18.7	30.7	Fine silky, 40 per cent; granular, 60 per cent.
	Sample untreated	61 *d*	.20	106,800	73,000	14⅓	23.7	49.1	Very fine silky.
	Rolled barrel, annealed in charcoal	61 A *e*	.20	102,550	60,000	14	21.3	37.1	Silky, interspersed with fine granulation.

a B, breach; M, muzzle.
b From muzzle end.
c From breech end.
d Midvale.
e Midvale in barrel. Does not possess sufficient firmness; stretches too much under proof and does not give smooth surface when reamed.

APPENDIX 2.

NOMENCLATURE AND DESCRIPTION OF THE GATLING GUN, CALIBER .30, MODEL 1895.

[Prepared at Springfield Armory, Springfield, Mass., by Lieut. T. C. Dickson, Ordnance Department United States Army.]

(7 plates.)

SPRINGFIELD ARMORY,
Springfield, Mass., November 28, 1896.

Respectfully forwarded to the Chief of Ordnance, United States Army.

The nomenclature and description have been prepared in accordance with instructions of the Chief of Ordnance dated July 13, 1895.

A. MORDECAI,
Colonel, Ordnance Department, U. S. A., Commanding.

Nomenclature.

[Those parts of which the names are in italics are bronze, the others are steel.]

Parts.	Figure.	Plate.
Adjusting knob	15	III
Adjusting-knob screw	14	III
Adjusting-knob spring	17	II
Adjusting-knob spring screw	17	II
Adjusting-knob washer	19	II
Barrels (10)	3	I
Barrel plate, front	3	I
Barrel plate, rear	3	I
Barrel-plate key	6	III
Breech casing	30	II
Breech-casing screws (6)	3	V
Cam cylinder	31	II
Cam-cylinder screws (2)	1	IV
Cam-cylinder recoil plate	31	II
Cam-cylinder recoil-plate screws (2)	31	II
Carrier block	32	II
Carrier-block dowel pin	32	II
Cascabel plate	29	II
Cascabel-plate screws (2)	13	V
Cocking switch	24	III
Cocking-switch knob	27	III
Cocking-switch knob sleeve	7	III
Cocking-switch plug	26	III
Cocking-switch plug pins	26	III
Cocking-switch plug spindle	8	III
Cocking-switch plug-spindle pin	25	III
Cocking-switch plug spring	16	III
Cocking-switch screw	23	III
Cocking-switch spring	17	III
Cocking-switch spring spindle	18	III
Crank	35	III
Crank handle	35	III
Crank-handle rivet	35	III
Crank key	34	III
Crank latch	17	V
Crank-latch screw	14	V
Crank-latch washer	16	V
Crank shaft	33	III
Crank-shaft collar	32	III
Crank-shaft spline	33	III
Crank-shaft worm	40	III
Crank-shaft worm key	39	III
Diaphragm	22	II
Diaphragm screws (2)	8	V
Ejector	12	V
Ejector pin	2	I
Ejector screws (2)	7	V
Extractors (10)	19	III
Extractor screws (10)	2	III
Firing pins (10)	20	III
Firing-pin bushings (10)	12	III
Firing-pin bushing screws (10)	1	III
Firing-pin nuts (10)	9	III
Firing-pin nut keys (10)	10	III
Firing-pin sleeves (10)	11	III
Feed-guide body	23	II
Feed-guide neck	15	II
Feed-guide neck screws (4)	27	II
Feed-guide pendulum	28	II
Feed-guide pendulum screw	24	II
Feed-guide pendulum spring	25	II
Feed-guide pendulum-spring spindle	26	II
Frame	2	I
Front sight	15	V
Front-sight screw	9	V
Front washer	31	III
Front-washer screw	22	III
Hopper	20	II
Hopper-hinge block	3	II
Hopper-hinge block screws (2)	5	II
Hopper-hinge pin	4	II

Nomenclature—Continued.

[Those parts of which the names are in italics are bronze, the others are steel.]

Parts.	Figure.	Plate.	Parts.	Figure.	Plate.
Hopper latch	14	II	*Main-shaft worm gear*	38	III
Hopper-latch screw	6	II	Main springs (10)	3	III
Hopper-latch spring	13	II	Pointing lever	11	IV
Hopper plow	12	II	*Pointing-lever binder*	9	IV
Hopper-plow screws (2)	11	II	Pointing-lever binder pin	25	V
Hopper throat, left wall	2	II	Pointing-lever binder-pin key	4	V
Hopper throat, right wall	1	II	Pointing-lever binder-pin washer	5	III
Hopper-throat dowel pin	2	II	Pointing-lever binder plate	5	IV
Hopper-throat plate	8	II	Pointing-lever binder screw	8	IV
Hopper-throat plate screw, left	4	IV	Pointing-lever pin	6	IV
Hopper-throat plate screw, right	3	IV	Pointing-lever pin nut	7	IV
Hopper-throat screws (4)	16	II	Pointing-lever pin washer	10	IV
Hopper-throat wheel	9	II	*Rear-guide nut*	13	III
Hopper-throat wheel pivot	10	II	Rear-guide nut key	4	III
Hopper thumbscrew	7	II	Rear-guide nut-key screw	2	IV
Locks (10)	21	III	Rear sight	36	III
Lock cylinder, body	33	II	*Rear-sight seat*	37	III
Lock cylinder, face	33	II	Rear-sight seat screw	28	III
Lock-cylinder screws (2)	5	V	Rear-sight spring	30	III
Lock-plug body	24	V	Rear-sight spring screw	29	III
Lock-plug chain and screw eye	26	V			
Lock-plug handle	26	V	IMPLEMENTS.		
Lock-plug hook	24	V			
Lock-plug hook screws (2)	24	V	Cascable-plate wrench	20	V
Lock-plug screw	6	V	Drift	22	V
Lock-plug sleeve	18	II	Lock screw-driver	11	V
Lock-plug sleeve screws (3)	21	II	Pin wrench	21	V
Main shaft	1	I	Pointing-lever pin-nut wrench	19	V
Main-shaft casing (leather)	1	I	Rear-guide nut wrench	18	V
Main-shaft spline, front	1	I	Shell driver	2	V
Main-shaft spline screw, front	1	I	Small screw-driver	10	V
Main-shaft spline, middle	1	I	T screw-driver	23	V
Main-shaft spline screws, middle (2)	1	I	Wiping rod	1	V
Main-shaft spline, rear	1	I			

DESCRIPTION.

The barrels and lock mechanism are secured to and rotate with the main shaft (fig. 1, Pl. I), which is supported at the front end by its bearing in the frame, and near the rear by that in the diaphragm. The first shoulder on the main shaft from its front end limits its movement forward by bearing against the front washer. The second shoulder forms a bearing for the front barrel plate; the third is for the rear barrel plate; the fourth is for the worm gear. The front thread is for the rear-guide nut; the rear for the adjusting knob. The front spline (fig. 1, Pl. I) insures the rotation of the front barrel plate; the middle spline (fig. 1, Pl. I) that of the rear plate and lock cylinder; the rear spline (fig. 1, Pl. I) that of the worm gear and adjusting knob washer. The hole in front of the second shoulder is for the front barrel-plate key; that through the front thread is for the rear-guide nut key, and the groove in rear of the adjusting-knob thread is for the adjusting-knob screw. That part of the shaft between the barrel plates is protected by a leather casing.

The front spline is secured in its seat by the front spline screw, the middle spline by its two screws.

The barrels (fig. 3, Pl. I), ten in number, are clustered cylindrically around and are connected with the main shaft by the barrel plates; the rear ends of the barrels are threaded and are firmly screwed into the holes in the rear plate; their front ends are secured by projecting through the holes in the front plate, which is held firmly against the shoulders on the barrels by the barrel-plate key. Slots are cut in the rear ends of the barrels and in the rear barrel plate for the reception of the extractor hooks. The rifling, bore, and chamber in each are the same as in the U. S. magazine rifle, caliber .30.

The carrier block (fig. 32, Pl. II) is held in position by the cylindrical projections on the rear barrel plate and lock cylinder entering its hollow interior, and the alignment of the ten longitudinal undercut grooves in its exterior, in which the locks move, is maintained, with those in the lock cylinder and with the barrels, by the carrier-block dowel pin (fig. 32, Pl. II). The cartridges are fed by the hopper into these grooves, which are shaped so as to guide them into the chambers when pushed forward by the locks. Near the rear end of the carrier block is a circumferential groove into which the plow projects.

The lock cylinder (fig. 33, Pl. II) comprises the body and face firmly united by the two lock-cylinder screws (fig. 5, Pl. V); the face closes the space between the body and breech casing. In the exterior of the body are ten longitudinal undercut grooves and through the face ten corresponding holes in which the locks move. The hole through its center fits the main shaft. The lock cylinder, carrier block, and rear barrel plate are firmly held together between the third shoulder of the shaft and the rear-guide nut (fig. 13, Pl. III) which is screwed on the shaft tightly against the rear end of the lock cylinder.

The rear-guide nut is retained in place by the rear-guide nut key (fig. 4, Pl. III) which is inserted through the screw hole in the lock cylinder and held there by the rear-guide nut-key screw (fig. 2, Pl. IV).

The cam cylinder (fig. 31, Pl. II) surrounds the body of the lock cylinder, its exterior surface snugly fits the interior of the breech casing, and it is secured to the diaphragm by the cam-cylinder screws (fig. 1, Pl. IV), so that it can not revolve with the main shaft. In the interior surface are two grooves, extending from the front end upward to the rear, in which the lugs of the locks work and by which is imparted to them their movement to and from the barrels. The front ends of these grooves (Pl. VI) are joined by a segment at right angles to the main shaft, called the firing flat and the rear ends by a similar segment called the loading flat. The right groove is called the cocking groove, and the left the extracting groove. The cocking-switch seat is an undercut slot extending forward from the rear end, the slot through the wall is for the cocking-switch screw. The notch in the loading flat receives the lock-plug hook. The front segment is faced with the recoil plate (fig. 31, Pl. II) which is hardened and resists the shock of discharge; it also extends a short distance down the extractor groove to protect it in case a cartridge should hang fire until after the lock has passed off the firing flat. The recoil-plate screws (fig. 31, Pl. II) hold the recoil plate in place; they are inserted from the rear end of the cylinder.

The diaphragm (fig. 22, Pl. II) supports the rear end of the main shaft; it is a heavy circular disk closely fitting the interior of the breech casing into which it is inserted from the front; it is held against the shoulder on the interior of the casing by the two cascable-plate screws (fig. 13, Pl. V), and is secured to the casing by the diaphragm screws (fig. 8, Pl. V). The hole near its rim permits the insertion and withdrawal of the locks by the lock plug; the notch receives the cocking switch when drawn to the rear.

The worm gear (fig. 38, Pl. III) occupies the space between the diaphragm and cascabel plate.

The cascabel plate (fig. 29, Pl. II) is screwed on and closes the rear end of the breech casing; it forms a support for the adjusting knob in regulating the head space. The countersunk hole in its center is for the adjusting-knob washer; through it are holes for the following: The lock plug, the cocking-switch sleeve, the two cocking-switch plug pins, the chain screw eye, and the two cascabel-plate screws; there are also two recesses for the cocking-switch plug pins. The slot in the edge of the lock-plug hole is for the lock-plug securing stud. When screwed into place the arrow on its rim should be opposite the mark on the breech casing.

The adjusting-knob washer (fig. 19, Pl. II) turns with the knob and main shaft, but has no bearing in its hole in the cascabel plate; the rear surface of its flange forms a bearing for the adjusting knob while its front surface turns against the plate thereby acting as a friction washer.

The adjusting-knob spring (fig. 17, Pl. II) is countersunk into the rear face of the washer and is held therein by the adjusting-knob spring screw (fig. 17, Pl. II); it locks the knob when adjusted to give the proper head space by entering one of the notches in its face.

The adjusting knob (fig. 15, Pl. III) is screwed on the rear end of the main shaft, and when completely on the adjusting-knob screw (fig. 14, Pl. III) will enter the inclined groove in rear of the thread. This insures the screwing of the knob fully into place, which is very important. When the knob is turned to the right the shaft with the lock cylinder, carrier block, and barrels is drawn to the rear with reference to the cam cylinder, thereby reducing the distance between the ends of the barrels and the firing flat, which decreases the head space; if the knob be turned to the left the head space will be increased. Five notches are cut in the face of the knob, and when it is turned so that the spring is in the right-hand notch the head space will be 0.063 inch; if in the second, 0.060 inch; the third, 0.057 inch; the fourth, 0.054 inch, and if in left, 0.051 inch. As the different bearings wear from use the head space corresponding to any notch will be increased so that in time the second notch will give 0.063 inch, etc.

The adjusting-knob screw slot limits the amount the knob can be turned in adjusting the head space.

The cocking switch (fig. 24, Pl. III) has an undercut groove through its front end, in which the head of a firing pin is caught and held until the lock has moved forward onto and a short distance along the firing flat, when the head, having passed through the groove, is released and the cartridge fired. A hole in the rear end receives the cocking-switch spring and spindle, and one through its side is for the cocking-switch screw. To avoid unnecessary snapping of the firing pins and for safety the cocking switch can be drawn to the rear out of reach of the firing pins.

The front end of the cocking-switch spring spindle (fig. 18, Pl. III) is enlarged for a bearing for the spring, and its rear end, which projects through its hole in the diaphragm, is knob-shaped; the hole in its front end is for the cocking-switch screw by which it is fastened to the switch.

The head of the cocking-switch screw (fig. 23, Pl. III) projects into its slot in the cam cylinder and prevents the removal of the switch.

The cocking-switch spring (fig. 17, Pl. III) surrounds the spindle and bears against the head of the latter and the diaphragm; it retains the switch in its forward position.

The cocking-switch knob (fig. 27, Pl. III) is the handle by which the switch is drawn to the rear. It is held in place on the rear of the cascabel plate by the knob sleeve; the hole through its center is for the sleeve, the rear end being enlarged to receive the cocking-switch plug; the two holes through its rim are for the plug pins.

The cocking-switch knob sleeve (fig. 7, Pl. III) is screwed into the knob through its hole in the cascabel plate, and the shoulder on its front end limits the distance the knob can be drawn from the plate.

The cocking-switch plug spindle (fig. 8, Pl. III) passes through the hole in the knob sleeve. Its front end is shaped to engage the knob on the rear end of the cocking-switch spring spindle and its rear end is secured in the hole in the center of the cocking-switch plug by the cocking-switch plug spindle pin (fig. 25, Pl. III). It should be assembled so the arrow on its rear end points in the same direction as that on the plug.

The two cocking-switch plug pins (fig. 26, Pl. III) are driven into their holes in the plug and project through those in the knob. When the knob is turned so these pins enter their holes in the cascabel plate the cocking switch will be in its forward position; when the knob is pulled to the rear until these pins are withdrawn from the holes in the plate and turned 90 degrees, so they will enter the two recesses in the plate, the cocking switch will be withdrawn out of reach of the firing pins and the knob be in the position of safety.

The cocking-switch plug spring (fig. 16, Pl. III) surrounds the plug spindle. Its front end bears against the knob sleeve and its rear against the plug. When the knob, in withdrawing the cocking switch, is pulled out as far as the sleeve permits, the tension of this spring is great enough to force the plug, against that of the cocking-switch spring, to the rear far enough to withdraw the plug pins from their holes in the cascabel plate; but its tension is not great enough to do this when the head of a firing pin is caught in the cocking-switch groove, for the tension of a mainspring would then be added to that of the cocking-switch spring. This prevents the withdrawal of the cocking switch when a firing pin is caught in it and the consequent danger from a liability to fire after the knob is turned to the position of safety.

The lock plug is seated in its holes in the cascabel plate and diaphragm and in the lock-plug sleeve. It is composed of the body (fig. 24, Pl. V) and the handle (fig. 26, Pl. V), united by the lock-plug screw (fig. 6, Pl. V), so the handle can turn independently of the body, and the hook (fig. 24, Pl. V) fastened to the body by the lock-plug hook screws (fig. 24, Pl. V); it is attached to the cascabel plate by the chain and screw eye (fig. 26, Pl. V). The securing stud on the front part of the handle, catching on the inside surface of the cascabel plate, retains the lock plug in its seat; when the handle is turned so the stud will be opposite its slot in the plate the lock plug can be withdrawn. The hook projects into its notch in the rear end of the cam cylinder and the lugs of the locks, while moving along the loading flat, pass through its notch. If the plug be withdrawn when the lug of a lock is in the hook notch the lock will be removed with it. A lock will be in this position when any one of the lines on the rear barrel plate is opposite the arrow on the hopper.

The breech casing (fig. 30, Pl. II) incloses and protects the mechanism. It is cylindrical in shape, with a rib on each side, by which it is fastened to the frame with the breech-casing screws (fig. 3, Pl. V); the two lugs projecting from its underside contain the holes for the pointing lever binder pin, the two holes beneath the ribs are for the diaphragm screws, and the one above the left rib near the front end is for the hopper latch. The place of manufacture, number, and caliber are stamped on the top of the casing.

The gun proper is assembled in and is supported by the frame (fig. 2, Pl. I). The hole through the front end, which is closed by the front washer screw (fig. 22, Pl. III), is for the front bearing of the main shaft; the holes in the left rail are for the ejector screws and pin and breech-casing screws, and those in the right are for front-sight, hopper-hinge, breech-casing and crank-handle latch screws. The trunnions (fig. 2, Pl. I) are driven into holes in the frame and upset, forming a part of it. The left rail is beveled opposite the carrier block to give an unobstructed passage to the empty shells.

The crank shaft (fig. 33, Pl. III) is seated in and revolves in its holes through the breech casing at right angles to the main shaft; the crank (fig. 35, Pl. III) is screwed on and keyed to its right end, which projects without the casing.

The worm (fig. 40, Pl. III) is fastened to the crank shaft by the crank-shaft worm key (fig. 39, Pl. III), and its rotation therewith is secured by the crank-shaft spline (fig. 33, Pl. III).

The crank-shaft collar (fig. 32, Pl. III) surrounds that part of the shaft between the worm and right side of the casing; it and the crank hold the shaft in position.

The crank key (fig. 34, Pl. III) prevents the unscrewing of the crank handle when it is turned backward.

The crank handle (fig. 35, Pl. III) is fastened to the crank by the crank-handle rivet (fig. 35, Pl. III).

Turning the crank (fig. 35, Pl. III) rotates the crank shaft, and this rotation is imparted to the main shaft by the worm and worm gear; it requires about one and three-fourths revolutions of the handle to produce a complete revolution of the main shaft, or to fire each of the ten barrels. To load and fire, the crank must be turned toward the muzzle.

The crank latch (fig. 17, Pl. V) is pivoted on and is secured to the underside of the frame by the crank-latch screw (fig. 14, Pl. V); the crank-latch washer (fig. 16, Pl. V), a cupped spring, is inserted between the screw head and latch to allow the latter to turn without the screw. When not firing, the crank handle should be secured by the latch; when firing, the latch should be turned out of the way, against the breech casing.

The front sight (fig. 15, Pl. V) is fastened to the frame by the front-sight screw (fig. 9, Pl. V); the sight of each gun is specially adjusted to correct for drift at 300 yards.

The rear-sight seat (fig. 37, Pl. III) is attached to the breech casing by the rear-sight seat screw and rear-sight spring screw (figs. 28 and 29, Pl. III).

The rear-sight spring (fig. 30, Pl. III) is also fastened by the spring screw; its rear end projects down into the sight hole in the seat and, bearing against the flat surface on the front of the sight, holds it when adjusted for any elevation and also retains it in its seat.

The rear sight (fig. 36, Pl. III) is a cylindrical rod with a flat upper end, in which a V sighting notch is cut. It is graduated from 300 to 1,000 yards, inclusive, the graduations being numbered and marked by circles on its surface. The sight is adjusted for any elevation by moving it until the graduation mark is even with the top of the sight seat.

The hopper (fig. 20, Pl. II) receives the cartridges from the feed guide and conveys them to the carrier block; its under surface is curved to conform to the carrier block and is so shaped that its front half will hold the cartridges in the grooves of the block and its rear half will allow the locks freedom in their movements; it is hinged in its seat in the hinge block on the hopper hinge pin. When closed, it is locked by the hopper latch. The right and left throat walls (figs. 1 and 2, Pl. II) are joined together by the dowel pin (fig. 2, Pl. II) and throat wheel pivot (fig. 10, Pl. II), and are fastened in the hopper by the throat screws (fig. 16, Pl. II).

The hopper-throat wheel (fig. 9, Pl. II) turns freely on its pivot in the throat, it delivers the cartridges to the carrier block properly directed and but one at a time; the rear teeth are longer than the front, to conform to the shape of the cartridge. The hopper-throat plate (fig. 8, Pl. II) merely replaces the metal removed for convenience in manufacture and is secured to the hopper by the throat-plate screws (figs. 3 and 4, Pl. IV). The opening in the hopper through which the cartridges pass is called the throat, it is enlarged at its upper end to admit the feed guide; the top of the left wall is partly cut away to discover the cause of any interruption in the regular movement of the cartridges and to facilitate its correction.

The hopper-latch screw (fig. 6, Pl. II) retains the latch and latch spring in their hole in the hopper; the spring (fig. 13, Pl. II), one end of which bears against the latch and the other against the latch screw, causes the latch (fig. 14, Pl. II) to project from the hopper into its hole in the breech casing and allows it to be withdrawn when the hopper is to be opened.

The hopper thumbscrew (fig. 7, Pl. II) secures the feed guide in its seat in the hopper.

The hopper hinge block (fig. 3, Pl. II) is attached to the frame by the hopper hinge block screws (fig. 5, Pl. II). The hopper hinge pin (fig. 4, Pl. II) is held in place by the rear barrel plate.

The plow (fig. 12, Pl. II) is fastened to the hopper by the plow screws (fig. 11, Pl. II); it projects into the circumferential groove at the rear end of the carrier block and ejects the empty cartridge shells as they are revolved against it.

The ejector (fig. 12, Pl. V) is a flat spring fastened to the frame by the ejector screws (fig. 7, Pl. V) and ejector pin (fig. 2, Pl. I). Its rear end projects in toward the carrier block; when any cartridge not fired is withdrawn from the chamber, the bullet is struck by it and the cartridge ejected.

The feed guide is made up principally of the body, neck, and pendulum. The neck (fig. 15, Pl. II), fastened to the lower end of the body by the neck screws (fig. 27, Pl. II), has an undercut groove through which the cartridges pass from the pendulum into the hopper. Two triangular lugs, one on each side of the groove project from the upper end of the neck into slots in the pendulum so that when the groove in the latter opposite the groove in the neck is emptied the pressure of the cartridges in the other groove on the inclined lug will swing the pendulum so that the full groove will be over the one in the neck and the supply to the hopper be not interrupted.

The upper end of the pendulum (fig. 28, Pl. II) is pivoted in its seat in the body by the pendulum screw (fig. 24, Pl. II). There are two parallel undercut grooves into which the cartridges are stripped from the paper boxes and through which they pass into the neck, and an arm extending upward assists in guiding the cartridges into the grooves. At the lower end is a lug, projecting into a cavity in the body, which limits the distance through which the pendulum can swing. In it is a shallow recess that receives the head of the pendulum spring spindle (fig. 26, Pl. II).

One end of the pendulum spring (fig. 25, Pl. II) bears against the end of the cavity and the other against the spindle head. This spring forces the pendulum to make a full swing from one side to the other and prevents it from stopping in the center, where neither groove would be over that in the neck.

That part of the feed-guide body (fig. 23, Pl. II) extending above the pendulum seat is flat, with a rib on its left side to guide the cartridges so each row in a box will freely enter one of the pendulum grooves.

A lock (fig. 21, Pl. III) is, in general, cylindrical, with a T-shaped rib extending its full length, which, working in the undercut grooves in the lock cylinder and carrier block, holds the lock in place and causes it to revolve with them. At the rear end and diametrically opposite to the rib is a triangular lug that works in the grooves in the cam cylinder; consequently, when the main shaft is revolved the lock will be rotated with it and at the same time moved parallel to it to and from the barrels. The extreme front end of the lock is reduced so as to enter the recesses in the rear barrel plate, and the edge on one side is slightly beveled to clear the plow. The firing-pin hole, which extends through its entire length, is contracted near the front end to conform to the shape of the firing pin. A channel cut lengthwise in its exterior receives the extractor. This channel is connected with the firing-pin hole by a slot. The notch in the side of the extractor channel opposite this slot permits the escape of gas entering the firing-pin hole from a leaky or pierced primer.

The extractor (fig. 19, Pl. III), a spring, is held in its seat by the extractor screw (fig. 2, Pl. III). The screw hole in the extractor is elongated to permit the extractor to have a small longitudinal movement. In rear of the hook is an inclined projection which engages a similarly inclined surface in the slot connecting the extractor channel with the firing-pin hole. When the lock is moved forward into the recess in the barrel plate, the extractor is pushed to the rear, disengaging this projection, which permits the hook to ride up the inclined slot in the rear end of the barrel so it will not rest on the cartridge when fired. When the lock is moved to the rear after the cartridge has been fired, this projection is engaged forcing the extractor downward and insuring a firm grasp of the hook on the shell.

The firing pin (fig. 20, Pl. III) is solid. Its rear end has a knob-shaped head by which it is caught in the groove of the cocking switch. The thread near its front end is for the firing-pin nut.

The firing-pin nut (fig. 9, Pl. III) is screwed on the firing pin and held in place by the firing-pin nut key (fig. 10, Pl. III). There are two rectangular channels in its exterior in which the arms of the firing-pin sleeve work. The nut holds the sleeve on the firing pin.

The rear end of the firing-pin sleeve (fig. 11, Pl. III) forms the front bearing for the mainspring, and the arms, which are longer than the nut, strike against the shoulder of the firing-pin hole in the lock, thereby leaving the firing pin and nut, when mainspring is not compressed, free to move between this shoulder and the sleeve. This allows the firing pin to rebound after firing, withdrawing the point within the lock.

The firing-pin bushing (fig. 12, Pl. III) is screwed into and closes the rear end of the firing-pin hole. Its front end forms the rear bearing of the mainspring and the firing pin passes through its center; it holds the firing pin and mainspring in the lock.

The firing-pin bushing screw (fig. 1, Pl. III) secures the bushing in the lock and can be inserted only when the bushing is screwed its entire length into the lock and the mark on the rear end of the bushing is opposite that on the lock.

The elevation and direction are given to the gun by the pointing lever (fig. 11, Pl. IV), the front end of which is hinged to the mount on the pointing-lever pin (fig. 6, Pl. IV). The pin is inserted from the left side and is retained in place by the pointing-lever pin washer (fig. 10, Pl. IV) and the pointing-lever pin nut (fig. 7, Pl. IV). The lug keys on the pin enter notches in the lever and washer, causing the pin and washer to move with the lever.

The lever is connected with the gun by the pointing-lever binder (fig. 9, Pl. IV), the upper side of which fits into its seat between the ears on the breech casing and is pivoted therein on the pointing-lever binder pin (fig. 25, Pl. V). The binder pin is secured in place by the pointing-lever binder pin washer (fig. 5, Pl. III) and the pointing-lever binder pin key (fig. 4, Pl. V).

The pointing-lever binder screw (fig. 8, Pl. IV) is seated in the left wall of the binder, and is manipulated by its handle. It bears against and, when screwed in, forces the pointing-lever binder plate (fig. 5, Pl. IV) against the lever so the latter is firmly clamped between it and the left wall of the binder.

To adjust the elevation, unclamp the binder screw and raise or lower the pointing lever; to give the direction, unclamp the mount and move the pointing lever sideways.

This gun is suited to mount upon the metallic carriage for machine guns, model 1890.

Pl. VII shows the principal exterior dimensions of the gun and feed guide. The tin strip feed, or "new positive feed," so-called, which is shown in dotted lines of the drawing, was originally furnished with the first installment of Gatling guns, caliber .30, procured by the Department in 1893, and is described in Appendix 42, Report of the Chief of Ordnance, U. S. A., 1893. These guns have been altered to adapt them to the gravity feed (Bruce) and to make them similar to the guns of model 1895.

The movement of the locks is shown in Pl. VI, which is a development of the cam cylinder, rear barrel plate, and a portion of the barrels, and shows the locks in different positions. The locks revolve with the lock cylinder and carrier block, and, when their lugs are in the cocking or extracting grooves, are simultaneously moved to and from the barrels. A section of the cocking switch is also shown.

Lock I is moving along the loading flat, and a cartridge has been dropped in front of it by the hopper. Locks II and III are moving forward along the cocking groove, and are pushing the cartridges into the chambers. The firing pin of Lock IV has caught in the cocking-switch groove and the mainspring is being compressed. Lock V has passed out of the cocking groove onto the firing flat, the cartridge is fully inserted in the chamber, and the compression of the mainspring completed; the firing pin is on the verge of escaping from the cocking-switch groove. Lock VI shows the position of the parts after firing. Locks VII and VIII are moving backward in the extracting groove and the extractors are withdrawing the empty shells. Lock IX has reached the position where the shell is ejected by the plow. Lock X has passed out of the extracting groove onto the loading flat, and is the next to occupy the position of No. I, having completed one revolution, during which it has inserted and fired one cartridge and extracted the shell.

DISMOUNTING AND ASSEMBLING.

In dismounting and assembling it is important to remember that the following keys are tapering: Barrel-plate key, rear-guide nut key, worm key, and crank key.

This gun should never be dismounted except by one thoroughly familiar with it, and then only when necessary for repairs or general cleaning.

It is dismounted in the following order:

1. Feed guide.
2. Locks: To do this, turn one of the lines on the rear barrel plate opposite the arrow on the hopper, turn the handle of the lock plug until the securing stud is opposite its slot in the cascabel plate, then draw the lock plug to the rear; a lock will be withdrawn with it. Replace the lock plug and turn the next line on the barrel plate opposite the arrow and proceed as before until all ten locks have been removed; then unscrew the chain screw eye and remove the lock plug.
3. Hopper-hinge screws, hopper, and hinge block, by opening hopper.
4. Crank-handle key; then crank, by unscrewing to the left or rear.
5. Gun from carriage or mount.
6. Adjusting-knob screw; then knob, washer, and spring.
7. Cascabel-plate screws; then turn the cocking-switch knob so the arrow on the end of the cocking-switch plug spindle points upward; slip the cascabel-plate wrench on the shaft and insert its lug in the lock-plug hole and turn it about an inch to the left to disengage the cocking-switch plug spindle from the cocking-switch spring spindle; the plate can then be unscrewed, but the cocking-switch knob must be kept fully drawn to the rear all the time to prevent the spindle striking the lock-plug sleeve.
8. Worm key; then crank shaft, worm, and collar.
9. Worm gear.
10. Breech-casing screws and breech casing.
11. Frame.
12. Rear-guide nut key screw and rear-guide nut key; then, with rear-guide nut wrench, the rear-guide nut.
13. Lock cylinder and carrier block.
14. Main shaft and front barrel plate, by driving shaft forward through rear plate.
15. Front barrel-plate key; then front plate from shaft.
16. Cam-cylinder screws, and draw the cam cylinder out of the front end of the breech casing.
17. Recoil-plate screws and recoil plate.
18. Cocking-switch screw and cocking switch.
19. Cocking-switch plug spindle pin; then plug, spring, and spindle.
20. Cocking-switch knob sleeve and knob.
21. Hopper-throat screws and throat walls; the wheel is removed and the walls separated by removing the throat-wheel pivot.
22. Neck screws, neck, pendulum screw, and pendulum of feed guide.

To dismount a lock, remove the bushing screw, insert the prongs of the lock screwdriver in the notches in the bushing, and unscrew it; remove the firing pin, bushing, mainspring, sleeve, and nut, assembled; remove the extractor screw, then the extractor. The assembled firing pin is dismounted by driving out the firing-pin nut key and unscrewing the nut.

Under no circumstance should the barrels be removed from the rear plate nor the diaphragm from the breech casing, except at an arsenal.

To assemble, reverse this order.

CLEANING AND CARE OF THE GUN.

As the residuum of smokeless powder, if not completely removed, corrodes the bore in a short time, care is required in cleaning the gun after firing.

To clean the barrels, insert an empty cartridge shell, the front end of which has been plugged, in the chamber of a barrel and turn the handle until its lock is on the firing segment; the barrel will then be on the right of the lowest; clean the bore with rags saturated with soda water, or, if that is not obtainable, with water; remove the shell and proceed in the same manner with the remaining barrels. Remove the locks and open the hopper, clean the chambers from the rear, then wipe both chamber and bore of each barrel thoroughly dry with clean rags, and, finally, oil them with cosmoline oil, leaving a light coating.

With dry rags clean the carrier block, giving special attention to the grooves, and apply a light coating of oil. The bottom of the hopper and throat should be similarly cleaned and oiled. Before inserting the locks they should be thoroughly cleaned and well oiled; in case gas has entered a firing-pin hole, the lock should be dismounted and all the parts and the hole and channels in the lock well cleaned.

All unburned grains of powder and dirt must be removed from the recesses in the rear barrel plate and barrels.

In general, the remaining parts can be cleaned with dry rags, without further dismounting; after cleaning, all surfaces should be lightly coated with oil.

It is imperative that all bearing surfaces be kept properly oiled, and especially the following: The front bearing of the main shaft, oil to be applied through hole in frame; the adjusting-knob washer, oil to be applied through hole in cascabel plate above the washer; the worm and worm gear, oil through first hole in top of breech casing in front of cascabel plate; the rear bearing of main shaft in diaphragm, oil through second hole in top of breech casing; the segments and grooves of cam cylinder, oil through third hole in breech casing; the crank shaft, oil through hole in each bearing in breech casing; the crank-handle rivet, oil through hole in handle; the throat wheel, oil to be lightly applied from bottom of hopper at each end; pendulum pivot, oil to be applied through screw hole. The ribs and lugs of the locks should at all times be kept lightly coated with oil.

REMARKS.

This model of the Gatling gun is equipped with the gravity feed (Bruce). The cartridges are fed directly from the paper box by stripping off the cover, placing their heads against the front of the feed-guide body and the rib on its left side, then pushing them down into the pendulum grooves and pulling off the box.

Should the regular movement of the cartridges through the feed guide or hopper stop, pressure of the hand on the top cartridges in the feed guide or the raising of them by inserting the finger in the opening in the left side of the hopper will in general remove the interruption.

Should the turning of the crank be stopped or become difficult by the jamming of a cartridge between the carrier block and hopper, by the striking of a cartridge against an empty shell left in the chamber by the failure of the extractor to remove it, or from some other cause, turning of the crank should be stopped, the hopper opened, and the cause of jam removed. Before closing the hopper all cartridges not in the chambers should be removed.

The firing pins should not be unnecessarily snapped. To prevent this, the cocking-switch knob should be turned to the safety position. It should not, however, be needlessly left in that position, or the cocking-switch spring will be weakened.

If, in firing, an extractor, firing pin, or lock be disabled, the lock should be removed and the firing continued with the other barrels.

The locks and barrels are numbered from 1 to 10; they need not be so assembled, the locks being interchangeable.

The adjustment of the head space is most important; if it is too small, the distance between the barrels and recoil plate will be less than the length of the locks; if too great, this distance will be longer than the locks, and the cartridge shells will be liable to rupture and leave a portion of the shell in the chamber. The proper head space is 0.063 inch, or that given by the right-hand notch in the adjusting knob when the gun is new. After the gun has been fired a number of times the proper notch should be found by trial; it will generally be that one farthest to the left with which the locks do not bind. If the empty shells show signs of rupturing, or if the primers set back and project beyond the heads of the shells, the head space is too great.

In order to obtain the greatest efficiency of fire with this gun, its rate of firing should not exceed 600 rounds per minute. Ordinarily the crank should be turned at the rate of one and a half revolutions per second, which will give about 525 rounds per minute. In an emergency this rate can be greatly increased.

(5868—Encs. 21 and 22)

PLATE I.

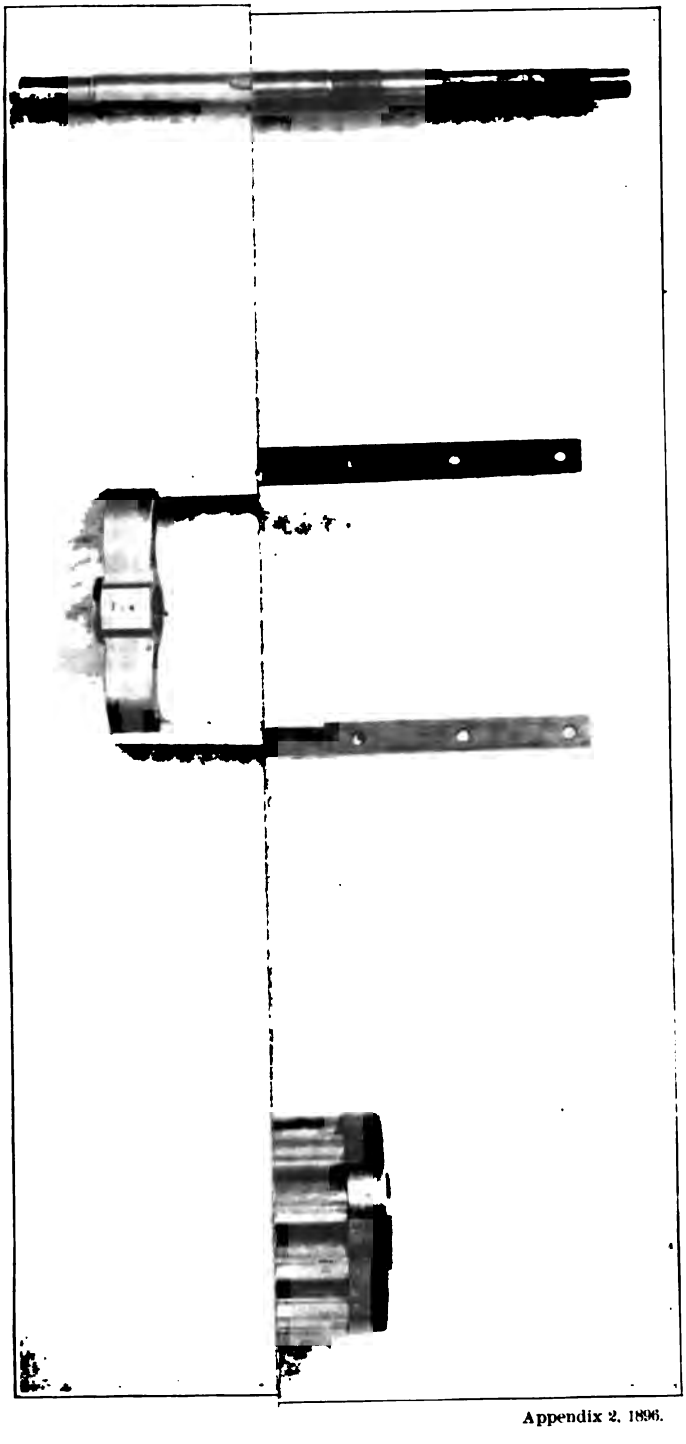

PLATE II.

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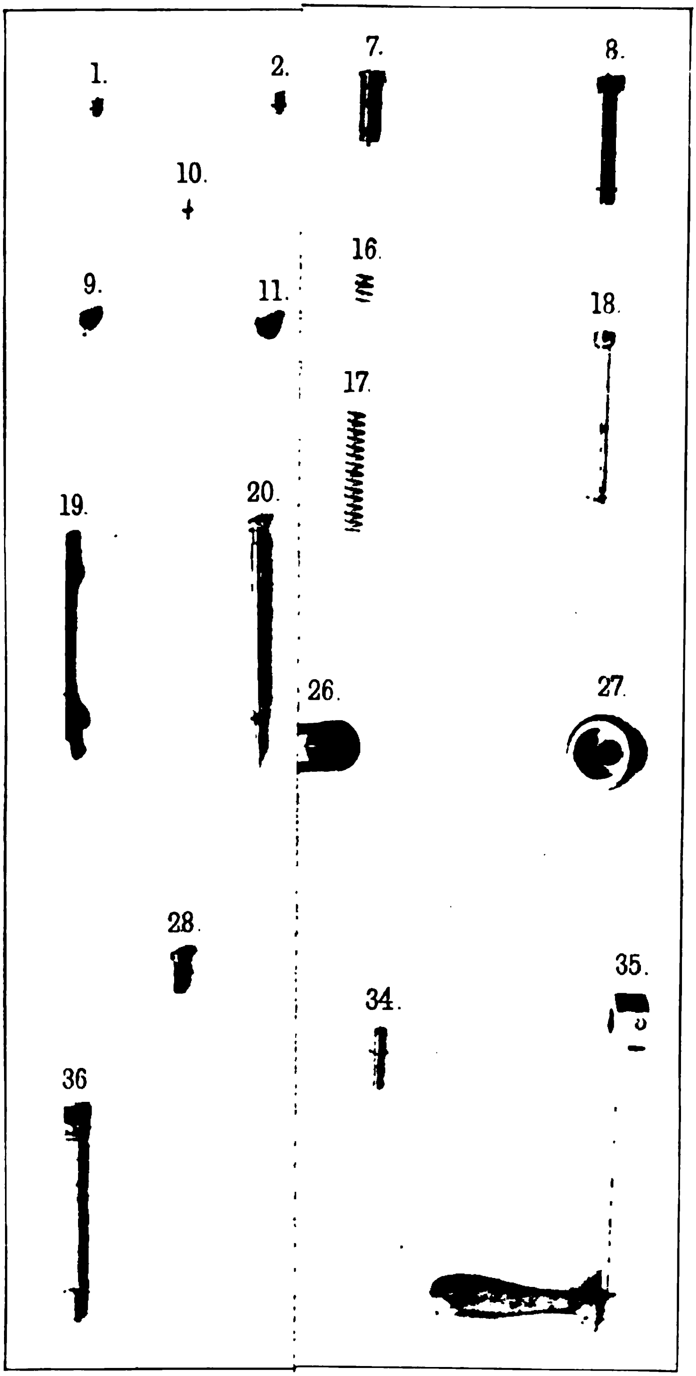
Appendix 2, 1896.

PLATE III.



Appendix 2, 1886.

PLATE IV.

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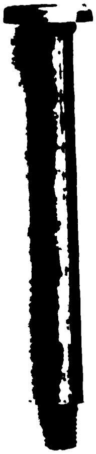

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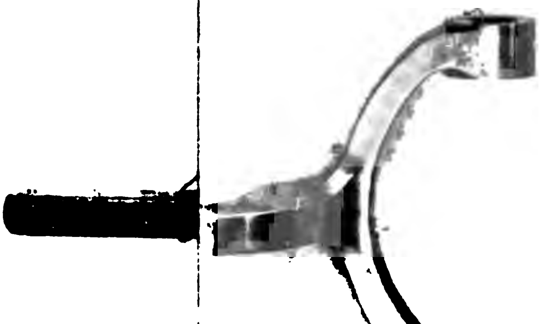
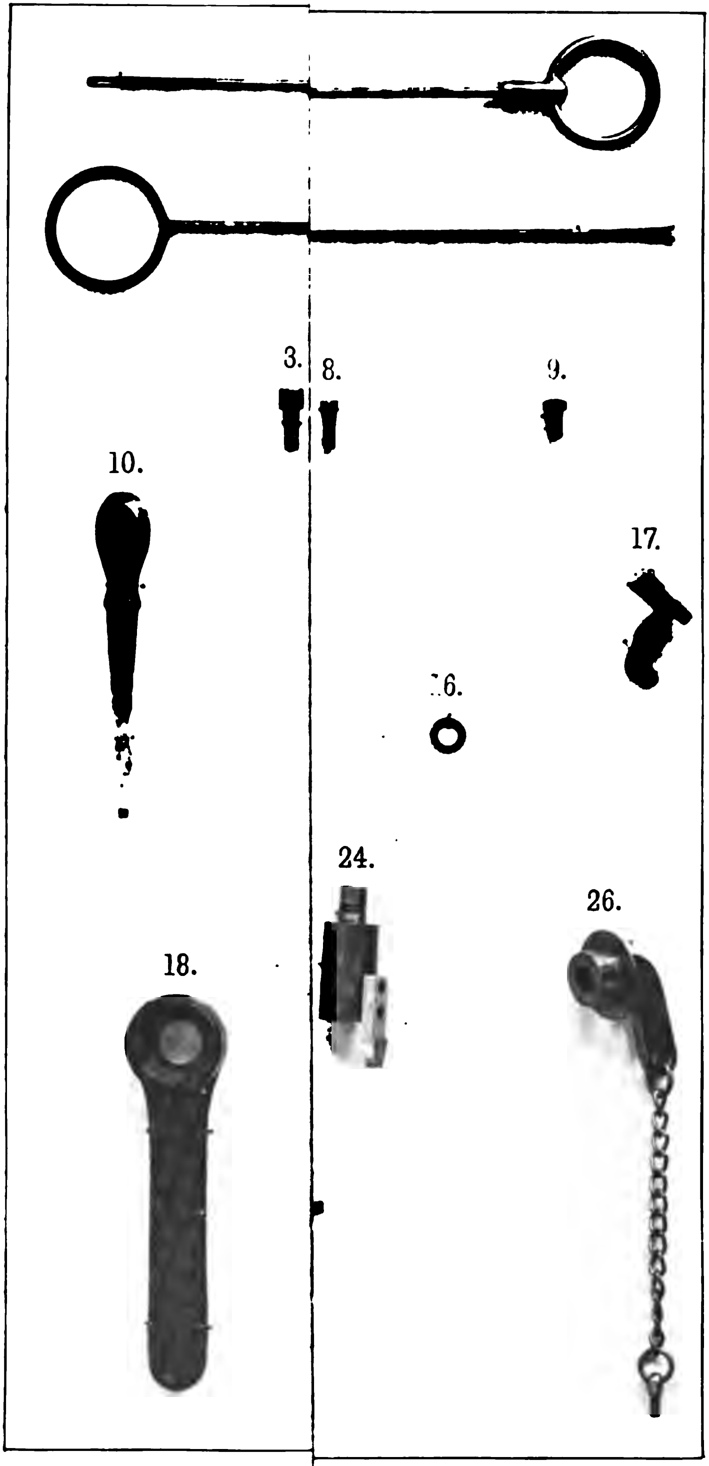
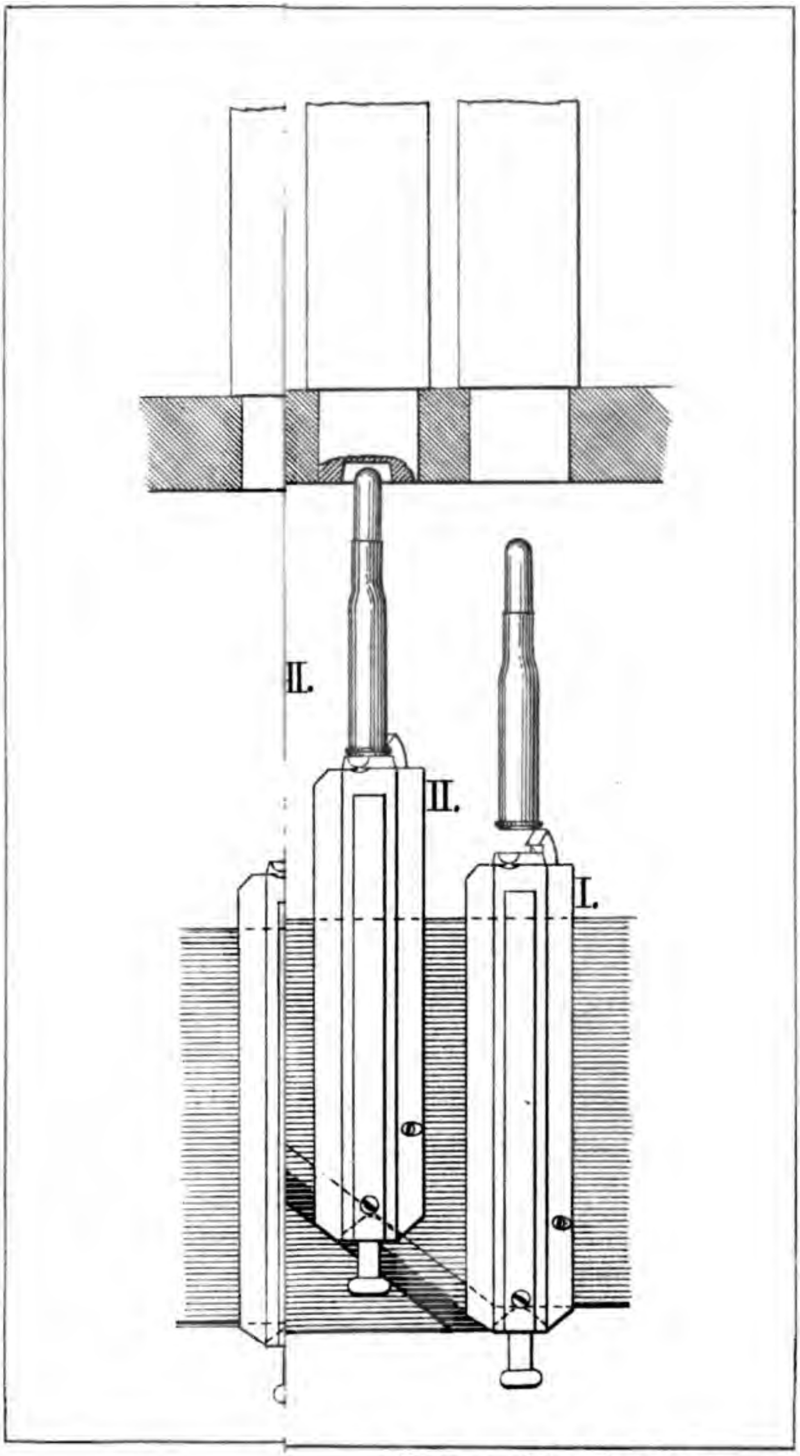


PLATE V.



Appendix 2, 1896.

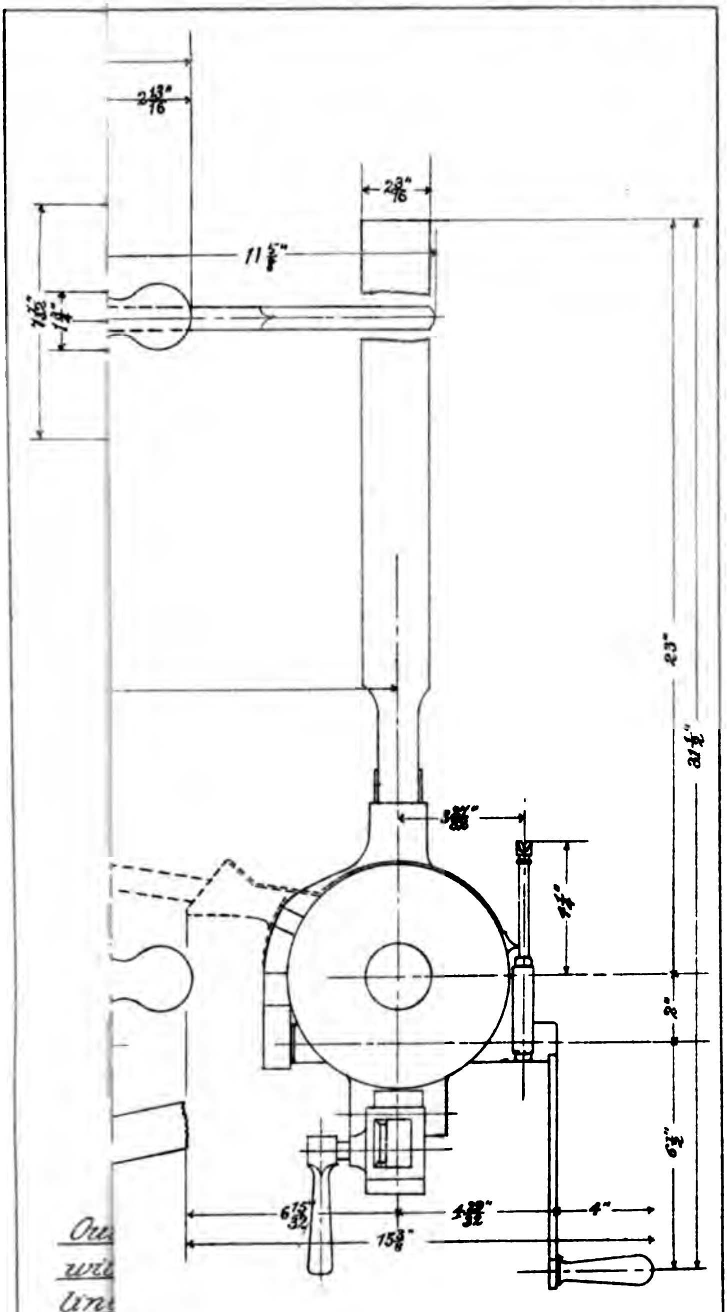
PLATE VI.



Appendix 2, 1896.

Ord 54 2

PLATE VII.



Appendix 2, 1896.

Ord 54 2

APPENDIX 3.

TEST OF WINCHESTER REPEATING SHOTGUN, MODEL 1893.

(1 plate.)

PROCEEDINGS OF A BOARD OF OFFICERS CONVENED AT SPRINGFIELD ARMORY BY VIRTUE OF THE FOLLOWING ORDER:

[Extract.]

POST ORDERS, No. 50.

SPRINGFIELD ARMORY, MASS.,
December 30, 1895.

* * * * * * *

III. A board of officers is hereby appointed to meet at this Armory on Thursday next, the 2d proximo, or as soon thereafter as practicable, to test the Winchester repeating shotgun, model 1893, in accordance with instructions of the Chief of Ordnance of December 12, 1895.

Detail for the board: Capt. James Rockwell, jr., Ordnance Department; Capt. C. W. Whipple, Ordnance Department; Second Lieut. Edward Sigerfoos, Fifth Infantry.

By order of Col. A. Mordecai:

TRACY C. DICKSON,
Lieutenant, Ordnance Department, U. S. A., Post Adjutant.

SPRINGFIELD ARMORY, MASS., *January 4, 1896.*

The board met pursuant to the foregoing order. Present, all the members.

The following letter of instructions from the Chief of Ordnance, United States Army, was transmitted to the board by the commanding officer, Springfield Armory:

OFFICE OF THE CHIEF OF ORDNANCE,
UNITED STATES ARMY,
Washington, D. C., December 12, 1895.

SIR: For the information of the Department and with the object of improving, if practicable, for the military service, the pattern of Winchester repeating shotgun, model 1893, of which 50 were procured and inspected at the Springfield Armory, under advertisement dated August 22, 1895, you are instructed to subject one of these guns to tests similar to those to which the Spencer and Winchester guns were subjected in 1886 and 1889, respectively, at the Armory.

On completion of the tests a report will be forwarded with recommendations to this office.

Respectfully,

D. W. FLAGLER,
Brigadier-General, Chief of Ordnance.

The COMMANDING OFFICER, SPRINGFIELD ARMORY.

After an informal discussion the board directed the recorder to request the commanding officer Springfield Armory, to furnish it with copies of the catalogue describing the gun, and any further statements or other information and illustrations showing improvements over previous models. Pending the receipt of the required information the board adjourned to meet at the call of the president.

SPRINGFIELD ARMORY, MASS., *January 8, 1896.*

The board met at the call of the president. Present, all the members.

The board then proceeded to examine the repeating shotgun, model 1893, Winchester Repeating Arms Company, submitted to it in accordance with the letter of instructions from the Chief of Ordnance. Sectional cuts and a description of the arm are given on pages 58 to 62, inclusive, of catalogue (inclosure 1).

The ammunition used in the tests was taken from a lot purchased by the United States from the Union Metallic Cartridge Company, Bridgeport, Conn., designated "New club loaded paper shells." They are marked as containing 3¼ drams[1] powder and 1⅛ ounces No. 1 buckshot. An examination of five of these taken from the box gave the following results: Weight of powder: First, 93 grains; second, 92 grains; third, 94 grains; fourth, 91 grains; fifth, 92 grains; average, 92.4 grains. Each cartridge contained twelve buckshot, the average weight of the five charges being 455.4 grains.

The tests were then proceeded with as follows:

I.—ACCURACY AND PENETRATION.

(1) At 50 yards: Six shots were fired at a target 4 by 6 feet. There were 64 hits out of a possible 72 in a space 4 feet by 4 feet 6 inches. Penetration, 1¼ inches in pine.

(2) At 75 yards: Six shots fired at a target 4 by 6 feet. There were 42 hits on the target. Penetration, 1⅛ inches in pine.

(3) At 100 yards: Six shots fired at a target 4 by 6 feet. There were 25 hits on the target. Penetration, ¾ inch in pine.

II.—DISPERSION AND PENETRATION.

(1) At 25 yards: One shot fired. There were 11 hits in a target 3 by 3 feet. Dispersion shown in fig. 1, Pl. I. Penetration, 2 inches in pine.

(2) At 50 yards: One shot fired. There were 8 hits in a target 3 by 3 feet. Dispersion shown in fig. 2, Pl. I. Penetration, 1¼ inches in pine.

Gun operated by Lieut. Edward Sigerfoos, Fifth Infantry.

Because of the low penetration as compared with that obtained by the board in 1889, the board decided to repeat the test for penetration when more suitable ammunition could be obtained from the Winchester Repeating Arms Company.

The board then adjourned to meet at the call of the president.

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[1] 1 dram = 27.34375 grains avoirdupois.

SPRINGFIELD ARMORY, MASS., *January 27, 1896.*

The board met at the call of the president. One member, Capt. C. W. Whipple, Ordnance Department, was absent because of sickness.

The board then proceeded with the following tests:

III.—RAPIDITY AND ACCURACY.

(1) As a single loader, gun empty: Six shots were fired, at a distance of 100 feet, at a target 6 by 4 feet. There were 71 hits on the target. Time, 28 seconds.

(2) As a single loader, gun empty: Six shots were fired. There were 72 hits. Time, 24 seconds.

(3) As a magazine arm: Six cartridges in the gun—1 in the chamber, 5 in the magazine. There were 72 hits on the target. Time, 9 seconds.

(4) As a magazine arm and single loader: Eighteen shots were fired, beginning with 1 cartridge in the chamber and 5 in magazine. There were 203 hits. Time, 1 minute 22 seconds. One cartridge was thrown from the chamber to the ground by a false motion of the operator, thus prolonging the time.

(5) As magazine arm: Fifteen shots were fired, beginning with 5 cartridges in the magazine. There were 175 hits. Time, 1 minute 5 seconds.

Gun fired by Lieut. Edward Sigerfoos, Fifth Infantry.

IV.—ENDURANCE.

To test the endurance of the arm 100 rounds were fired. Average time for loading magazine, 5 seconds. Average time for emptying magazine, 1 second. The 100 shots were fired consecutively and without intermission. In no instance did the gun fail to work. At the end of the one hundredth round the gun was carefully examined and every part found to be in good condition. The barrel was so hot as to char the hand guard, but the heat in no way disabled the gun nor prevented its further use.

Gun fired by R. T. Hare.

At the completion of this test the board adjourned to meet at 2 p. m. January 28, 1896.

The board met pursuant to adjournment at 2 p. m. Capt. C. W. Whipple absent because of sickness.

The tests were then continued, as follows:

V.—DEFECTIVE CARTRIDGES.

The following defective cartridges were fired, the gun being in a fixed rest:

(1) Shell cross sawed through head; one cut entirely through the brass head; one through rim. Slight escape of gas through cuts, but not noticeable outside of breech mechanism. Extractor not injured.

(2) Shell filed through in four places about rim. Result same as preceding.

(3) Shell with two longitudinal cuts the whole length of shell from head to top. No escape of gas. Shell easily extracted.

VI.—EXCESSIVE CHARGES.

The following excessive charges were then fired, the gun being in a fixed rest:

(1) 120 grains powder, 12 buckshot.
(2) 120 grains powder, 15 buckshot.
(3) 135 grains powder, 12 buckshot.
(4) 135 grains powder, 15 buckshot.

The gun was closely observed after each shot. It worked perfectly and was found to be in good condition.

The board then adjourned to meet at 2 p. m. January 29, 1896.

SPRINGFIELD ARMORY, MASS., *January 29, 1896.*

The board met pursuant to adjournment. Capt. C. W. Whipple absent because of sickness.

The gun was then subjected to the following test:

VII.—DUST.

The piece was exposed, in the box prepared for the purpose, to a blast of fine sandstone grit and dust for 2 minutes; was removed, the magazine filled, and ten rounds fired. The mechanism worked hard for two or three rounds, but during the remainder very well. The piece was in no way disabled.

The board then adjourned to meet at 2 p. m. January 31, 1896.

SPRINGFIELD ARMORY, MASS., *January 31, 1896.*

The board met pursuant to adjournment. Capt. C. W. Whipple, Ordnance Department, absent because of sickness.

The gun had, on the 29th instant, been subjected to the following:

VIII.—RUST.

The breech mechanism was cleaned of grease and the chamber of the barrel greased and plugged. The butt of the gun was then inserted to the height of the chamber in a strong solution of sal ammoniac for 10 minutes and afterwards left for 48 hours in a warm room. On examination the gun was found to be very badly rusted. The breech mechanism was opened by means of the action slide after two trials and was found to be thoroughly rusted. The magazine was filled and five rounds fired without intermission. The mechanism worked hard but the piece was in no way disabled.

The board then adjourned to meet at the call of the president.

SPRINGFIELD ARMORY, MASS., *February 5, 1896.*

The board met pursuant to the call of the president. Capt. C. W. Whipple absent because of sickness.

The commanding officer, Springfield Armory, transmitted to the board 50 rounds of ammunition, marked "Winchester rival paper shot shells," stamped as containing 3¼ drams powder and 1⅛ ounces 00 buckshot. An examination of one of these shells showed them to contain 91.5 grains of black powder and 9 buckshot weighing 515 grains.

The board then proceeded with the following test:

IX.—ACCURACY, PENETRATION, AND DISPERSION.

At 100 feet: Five shots were fired at a target 4 by 6 feet. There were 45 hits in a space 3 by 2.5 feet out of a maximum of 45. Penetration, 2½ inches in pine. A few shots penetrated 3 inches of pine.

Dispersion shown in Pl. I, fig. 3.

Gun fired by Lieut. Edward Sigerfoos, Fifth Infantry.

CONCLUSIONS.

In the preliminary examination of the shotgun, the board was of the opinion that certain of the component parts—notably, the firing-pin spring, cartridge-stop spring, and sear—were too light and weak for hard service, but the result of the severe tests to which the gun was subjected showed that every part was strong and serviceable.

The board finds that the gun possesses the advantages claimed by the manufacturer. The sliding forearm movement insures the ease of manipulation from the shoulder, and the gun can be loaded, unloaded, or fired with safety and sufficient rapidity. It is accurate, gives good penetration, especially with the cartridge containing heavier buckshot, and has little recoil. The working parts are few in number and are simple, strong, and well made; and the board is of the opinion that the arm is especially well adapted to the purpose for which (see indorsement of Chief of Ordnance, inclosure 2) it is intended. The board has, therefore, no suggestions nor recommendations to suggest in the way of improving the gun for the use of sentinels in the military service.

There being no further business before it, the board adjourned sine die.

JAS. ROCKWELL, Jr.,
Captain, Ordnance Department.
C. W. WHIPPLE,
Captain, Ordnance Department.
EDWARD SIGERFOOS,
Second Lieutenant, Fifth Infantry, Recorder.

The foregoing proceedings and opinions are approved.

A. MORDECAI,
Colonel, Ordnance Department, U. S. A., Commanding.

(9195)

Plate 1.

Fig. 1.

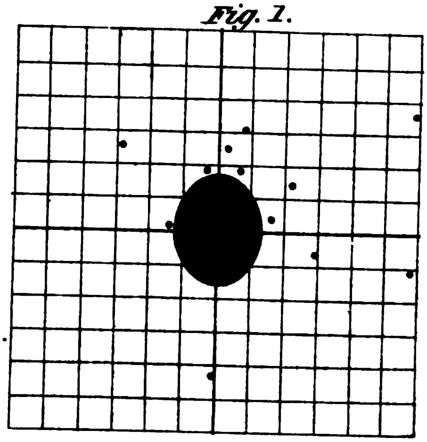


Fig. 2.

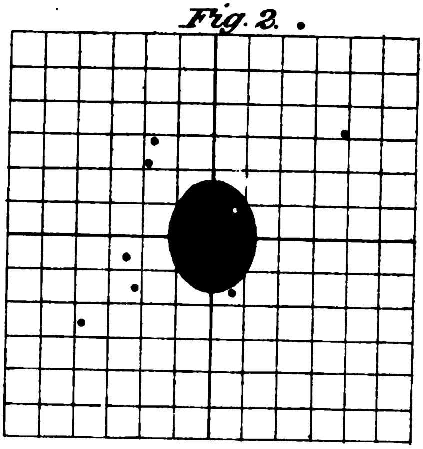
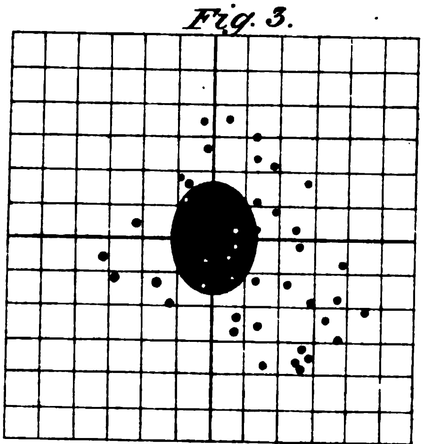


Fig. 3.



Appendix 3, 1896.

Ord 54 2

APPENDIX 4.

MANUFACTURE OF .30-CALIBER AMMUNITION.

(6 plates.)

FRANKFORD ARSENAL,
Philadelphia, Pa., September 29, 1896.

SIR: In compliance with instructions dated Ordnance Office, September 23, 1896, calling for a report upon the progress of manufacture of .30-caliber ammunition at the Frankford Arsenal during the past year, I have the honor to report as follows:

There were manufactured and issued in the fiscal year 1896:

Caliber .30.	Manufactured.	Issued.
Ball cartridges	5, 067, 121	4, 613, 468
Blank cartridges	1, 207, 150	1, 031, 620
Gallery cases, new model	16, 160	500
Gallery cases, old model	14, 580	9, 824

It is satisfactory to find that the service cartridge, manufactured from the 0.12-inch metal since August, 1895, is giving general satisfaction throughout the service.

There is provided in this cartridge (Pls. I and IV) an adequate thickness of base to meet all probable conditions of head space or depth of extractor cut in the rifle, exceeding even the maximum limits.

For this reason it is not expected that the breaks in the cartridge rim, which occasionally occurred with the 0.08-inch thickness metal cartridge case (Pl. II), will reappear, and it is now believed that the gas escape from this cause is a thing of the past. In fact it may be stated that as a single loader the present model .30-caliber cartridge is a pronounced success, as it relates to case, primer, powder charge, and projectile.

As a reloader, in all endurance tests at this arsenal, its life ranges up to and beyond 12 rounds, and except for altered molecular structure of metal incident to galvanic or chemical action after firing and under conditions hereinafter specified, it might be depended upon to maintain this endurance.

THE CALIBER .30 BALL CARTRIDGE FOR RIFLE AND CARBINE.

(Pls. I and IV.)

The caliber .30 ball cartridge consists of a tinned brass case charged with smokeless powder, a primer containing 0.36 grains of composition, and a jacketed bullet 220 grains in weight.

The case consists of a frustum of a cone (the body) and a cylinder (the neck) joined by a shoulder, a section of which is an ogee.

The powder used is a composition of nitrocellulose and nitroglycerin, and up to the present time has been procured from three American firms, and is denominated Peyton, Du Pont, and W.–A., respectively. The charge varies with the powder used, and is from 35 to 42 grains.

The bullet is nonlubricated and has a core of lead and tin composition, jacketed with cupro-nickeled steel. In form the bullet consists of a right cylinder, a frustum of a cone, a frustum of a spindle, and a spherical segment. The right cylinder and conical frustum are joined by a groove or cannelure, into which the mouth of the case is crimped. The cupro-nickeled steel used in the jackets is an imported metal and consists of so-called sheet steel (believed to be a high grade of Norway iron) laminated on either side with cupro-nickel. An American product known as cupro-nickel is in the experimental stage, as a substitute for the cupro-nickeled steel.

The core of the bullet is composed of 1 part of tin and 25 parts of lead, by weight. The composition is varied slightly in order to keep constant at 220 grains the weight of the finished bullet.

The primer is composed of four parts, viz: The cup, the brass anvil, the tin-foil disk, and the composition. The cup is of copper or brass tinned, and contains the composition. This is covered and waterproofed by the tin-foil disk. In plan the anvil is a circle with two small semicircular portions removed from its opposite sides. These two openings form vents for the passage of the flame from the composition to the powder.

The composition consists of:

	Per cent.
Fulminate of mercury (moist)	59.37
Chlorate of potash	21.89
Glass	15.62
Mealed powder	3.12

The weight of the cartridge complete varies from 435 to 442 grains, depending on the powder used and the variation between limits of case and ball. One thousand are packed in pasteboard boxes containing 20 each, and, encased in wood, weigh 78 or 79 pounds.

The standard instrumental velocity of this ammunition is 1,960 feet per second, measured at a distance of 53 feet from the muzzle, with an allowed variation of but 15 feet per second on either side of the standard. The standard instrumental velocity corresponds to a muzzle velocity of about 2,000 feet per second.

MACHINES.

Two large-size double-action presses have been procured and put in operation for the 0.12-inch metal .30-caliber cartridges, which, when working to full capacity, will cut 120,000 cups per diem.

Two improved gas annealing machines have been constructed for the purpose of thoroughly annealing the end before forming the neck of the bottle-shaped cartridge case, which operation was not satisfactorily accomplished with the extemporized machines employed in the manufacture of the earliest cartridge product.

One improved primer inserter, 3 grooving machines, and 2 bullet-sizing machines have also been constructed.

One additional bullet-assembling machine has been procured by contract, this being a great labor-saving device, performing at one stroke six separate operations. Two machines of the same kind will be finished under contract on January 1, 1897, making four machines in all for this arsenal, sufficing for the manufacture of 80,000 .30-caliber bullets per diem.

One bullet-jacket trimming machine has also been completed, and will be followed by others now in the course of construction, effecting a large saving in cost over our present method of trimming.

At present the cartridge product of this arsenal is restricted to 23,000 rounds of .30-caliber ammunition, with a proportion of other cartridges not exceeding 8,000 rounds per diem, but effort is being made to attain a daily output of 50,000 rounds all told, including blanks for all calibers, by February, 1897; and after July, 1897, this will be further increased to include 30,000 caliber .30 ball cartridges, but for this purpose a number of additional machines will be procured or constructed.

From the nature of the new designs for smokeless-powder cartridges it is found in almost every instance that all the machines introduced to facilitate operations pay for themselves, in savings effected over previous methods, within as brief a period as two years.

TESTS OF AMMUNITION.

The closest attention has been given to the tests, both in the laboratory and ballistic divisions at this arsenal, and special reports have been rendered from time to time showing that, from the ballistic standpoint, the cartridge product of this arsenal and the performance of the U. S. service magazine rifle can not be excelled.

Referring to tests contained in my report of January 11, 1896, it will be seen that magazine rifle No. 1924, which had previously been fired 13,388 times, gave as good target, at 500 yards range, as the best recorded at the proof house.

Table No. I, which follows, also shows how this rifle, 1924, compares for velocities with an entirely new rifle, 9789 (ten shots from each rifle):

TABLE I.

Velocities.	Rifle No. 1924.	Rifle No. 9789.
	Feet per sec.	*Feet per sec.*
Maximum	1,952	1,986
Minimum	1,925	1,938
Mean	1,942.5	1,963.9
Mean variation	5.9	13.5

The following table is intended to show the comparative accuracy, at 500 yards, of the caliber .45 and caliber .30 rifles, derived from 1,000 consecutive targets of ten shots each fired at this arsenal. The arms were held in the fixed rest, and the mean radius is estimated from the center of impact of each group. (It is reported that in this whole series there may have been some 3 or 4 drop shots, which were thrown out of the record.)

TABLE II.—*Comparative test of caliber .45 and caliber .30 ammunition of daily manufacture.*

	Caliber .45. (*a*)	Caliber .30. (*b*)
	Feet.	*Feet.*
Mean radius	0.7771	0.6161
Maximum radius	1.15	1.020
Minimum radius	0.48	0.360
Extreme variation	0.67	0.660
Mean vertical deviation	0.5604	0.4520
Maximum vertical deviation	1.010	0.795
Minimum vertical deviation	0.280	0.210
Extreme variation	0.730	0.585

[a] Beginning May 23, 1893; ending March 5, 1895.

[b] Beginning July 25, 1894; ending May 22, 1895.

The following table (III) shows the comparative uniformity of velocities obtained with caliber .45 and caliber .30 ammunition at this arsenal, for the periods and number of shots specified:

TABLE III.—*Velocities with caliber .45 and caliber .30 ammunition of daily manufacture.*

	Caliber .45.(*a*)	Caliber .30.(*b*).
	Feet per sec.	*Feet per sec.*
Mean velocity	1,276.46	1,977.04
Maximum velocity	1,299	2,008
Minimum velocity	1,259.5	1,951.7
Extreme variation	39.5	56.3

[a] Beginning September 7, 1893; ending March 5, 1895; 553 sets of 6 shots each; total, 3,318 shots.
[b] Beginning July 25, 1894; ending May 22, 1895; 547 sets of 10 shots each; total, 5,470 shots.

Again, in grading new rifles for velocity, the results shown in Tables IV, V, and VI were derived.

Comparative test of ten new magazine rifles, caliber .30, fired for velocity; ammunition, 34.6 grains Peyton powder, lot No. 3, cannelured for crimp bullet, $G_{.36}$ primer, and 43 grains W.-A. No. 1 powder, cannelured for crimp bullet; ammunition fired in alternation in each gun.

TABLE IV.

[34.6 grains Peyton No. 3 powder, cannelured bullet.]

Gun No.									
17105.	17236.	17258.	17260.	18647.	21218.	21236.	21244.	21254.	21261.
Ft. sec.	*Ft. sec.*	*Ft. sec.*	*Ft. sec.*	*Ft. sec.*	*Ft. sec.*	*Ft. sec.*	*Ft. sec.*	*Ft. sec.*	*Ft. sec.*
1,942	1,934	1,934	1,944	1,936	1,916	1,908	1,966	1,936	1,906
1,980	1,966	1,934	1,942	1,946	1,936	1,916	1,962	1,936	1,956
Missed.	Missed.	1,956	1,980	1,958	1,923	1,908	1,960	1,908	1,923
1,944	1,942	1,980	1,940	1,964	1,926	Missed.	Missed.	1,962	1,908
1,942	1,954	1,960	1,942	1,938	1,934	1,905	1,942	1,923	1,936
[a]1,952	[a]1,949	[a]1,952.8	[a]1,949.6	[a]1,948.4	[a]1,927	[a]1,909.2	[a]1,957.5	[a]1,933	[a]1,925.8

[a] Mean.

TABLE V.

[43 grains (*a*) W.-A. No. 1 powder, cannelured bullet.]

Gun No.									
17105.	17236.	17258.	17260.	18647.	21218.	21236.	21244.	21254.	21261.
Ft. sec.	*Ft. sec.*	*Ft. sec.*	*Ft. sec.*	*Ft. sec.*	*Ft. sec.*	*Ft. sec.*	*Ft. sec.*	*Ft. sec.*	*Ft. sec.*
1,996	2,006	2,012	2,002	2,022	1,990	1,982	2,020	2,022	1,986
2,024	2,026	2,026	2,022	2,006	2,002	1,994	2,014	2,004	1,994
2,014	2,034	2,038	2,028	2,032	1,994	2,014	2,028	2,006	2,002
2,016	2,034	2,046	2,024	2,032	1,998	2,002	2,042	2,006	2,018
2,004	2,034	2,042	2,028	2,022	2,000	2,012	2,036	2,008	2,014
[b]2,010.8	[b]2,026.8	[b]2,032.8	[b]2,020.8	[b]2,022.8	[b]1,996.8	[b]2,000.8	[b]2,026.8	[b]2,009.2	[b]2,002.8

[a] A smaller charge should have been used to bring this velocity to the standard—1,960 feet per second.
[b] Mean.

TABLE VI.—*Velocity and pressure. Pressure gun No. 12.*

[Beginning: Thermometer, 27°, dry; barometer, 30.37″. Ending: Thermometer, 26°, dry; barometer, 30.39″.]

34.6 grains Peyton No. 2 powder.		43 grains (*a*) W.-A. No. 1 powder.	
Feet per second.	Pounds per square inch.	Feet per second.	Pounds per square inch.
1,976	43,800	2,060	42,950
1,986	40,900	2,082	43,300
1,966	42,950	2,072	44,033
1,958	40,900	2,080	43,150
1,972	40,466	2,078	44,233
1,978	42,450	2,060	41,933
1,914	40,100	2,046	42,950
1,980	42,950	2,070	43,450
1,990	40,266	2,065	44,100
1,974	42,700	2,046	41,033
Mean, 1,969.4	41,748	2,065.9	43,113
	Maximum 43,800		Maximum 44,233
	Minimum 40,100		Minimum 41,033

[a] A smaller charge should have been used to bring this velocity to the standard—1,960 feet per second.

From the foregoing tables (IV, V, and VI) it will be observed that there is a slight difference in the velocity records of different rifles when employing ammunition prepared under identical conditions, and therefore it is that these rifles, which were to be employed for special experimental purposes, were graded for velocity, as is shown.

Five of the above lot of rifles were set aside by direction of the Chief of Ordnance for Capt. S. E. Stuart, Ordnance Department, inspector of powder, to be employed by him in the "erosion tests" of several experimental and contract powders, the results of which were reported by the Arsenal board for the test of material, and the report forwarded to the Department through the inspector of powder.

The record which follows is of interest in showing a comparative test for accuracy of the new contract (1896–97) Peyton, and Laflin and Rand W.-A., smokeless powders. Ten shots for each target were made from alternate shots with the two powders.

Comparative test of new contract smokeless powders at Frankford Arsenal.

SEPTEMBER 26, 1896.

[Wind from rear, 12 miles per hour. Thermometer: Dry, 77°; wet, 65°. Barometer, 30.35″. Heavy accuracy barrel firmly locked and recoil checked.]

	Hand loaded at proof house.		Machine loaded at shop.	
	Peyton No. 7.	W.-A. No. 4.	Peyton No. 7.	W.-A. No. 4.
	Foot	*Foot.*	*Foot.*	*Foot.*
Radius	0.645	0.59	0.60	0.74
Mean vertical deviation	0.360	0.357	0.450	0.447

SEPTEMBER 28, 1896.

[Calm, wind vane pointing to wind from rear. Thermometer: Dry, 71°; wet, 69°. Barometer, 30.18″. Magazine rifle No. 38128.]

Radius	0.70	0.74	0.525	0.89
Mean vertical deviation	0.580	0.507	0.350	0.692

POWDERS.

The reports of the board for inspection and tests of material, and of the officer in charge of the laboratory, forwarded separately, furnish all the information desired under this head.

Reference in this connection is also invited to the report of September 24, 1896, relative to the effects on the cartridge case due to the presence of partially consumed grains of powder in the rifle chamber, as well as to the residuum of certain powders, effects of which it is thought in the absence of facilities for making the tests might obstruct the workings of automatic or other delicately constructed machine guns.

In view of the erosion tests made at this arsenal, under the supervision of Capt. S. E. Stuart, Ordnance Department, inspector of powder, and the information derived relative to smokeless powders (Peyton and W.-A. smokeless), furnished for the small-arms cartridge under contract, a liberal limit has been set by me for powders at present delivered before condemnation for undue erosion or corrosion. Before new supplies, not as yet ordered, are delivered, it is thought that the restrictions should be more exacting.

BULLETS.

Reference in the last annual report has been made to the bullet jacket metal at the time undergoing tests, and although the cupro-nickeled steel has, as heretofore, proved entirely satisfactory, it was still hoped that a domestic product denominated cupro-nickel might fulfill the necessary requirements, as in tests of several samples, furnished by the Coe Brass Manufacturing Company and the Scovill Manufacturing Company, it gave excellent results.

A contract was therefore about to be entered into with the former firm, but the first delivery of 1,000 pounds showed that, owing to unfamiliarity with the delicate process of annealing, this alloy was calculated to invite disaster by its employment. Fifty thousand drawn cups, annealed after drawing by the firm furnishing them by a special process, were worked up into bullets, but with such suspicion attaching to the product that the bullets are retained as "experimental" and to be used only for such purpose. The work of this arsenal was somewhat delayed owing to the nonarrival of a supply of the cupro-nickeled steel from Germany, and there is unfortunately no good ground to justify a change from this certain and safe jacket to one which can only at best be regarded as a variable and uncertain alloy. A change at this time to a new metal or alloy would be attended by an added risk to that which is imposed by the new cannelure on bullet for crimp, and which latter renders the bullet jacket weaker at this section than on other parts of its surface.

PRIMER.

The primer has been changed slightly in form during the past year, but this is only in the anvil, which has been somewhat narrowed up for better ventage of primer gas to powder charge and the bottom of the pocket of case cut away in a manner to funnel shape the vent, since it has been ascertained in the course of experiments that the arch anvil, besides spreading at the span, has a tendency to set down and close the vent, and that this action retards the flow of gas and induces hang fires.[1]

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[1] The discovery of this defect was made by the effort to employ a flatter arch anvil, when it was seen that the burr on anvil partially closed the vent and induced hang fires.

The composition has also been altered from $E_{.35}$ (the added mealed powder increasing the heat of flame)—

	Per cent.
Fulminate of mercury (moist)	61.50
Chlorate of potash	19.00
Glass	18.00
Mealed powder	1.50
	100.00

to $G_{.35}$:

	Per cent.
Fulminate of mercury (moist)	59.37
Chlorate of potash	21.89
Glass	15.62
Mealed powder	3.12
	100.00

With these changes it is now found that hang fires are not known even with powders as obdurate as those of the nitrocellulose class.

Another important change has been made in the return from the brass to the copper cup for the primer. This has eliminated the splits and cracks which necessitated visual inspection of each individual primer cup and saves the expense attendant upon a corps of inspectors. The Department understands that we were forced to employ brass, in lieu of copper, owing to the puncturing of primers by bad form of striker in the first issue of the new magazine rifle, but that latterly with the improved form of striker and its careful adjustments the copper serves its original purpose in the primer.

The use of a hard brass anvil is deemed unavoidable in order to insure ignition of the primer composition; but as the latter is well embedded in varnish and incased with tin foil, there is no apprehension of the deterioration incident to the action of fulminate of mercury with chlorate of potash on the brass. It would be better, however, if the whole make-up of the primer could be copper, since it is well established that "copper will reduce insoluble mercurial salts when moist and mixed with some suitable chemical agents. Fulminate of mercury, from the little affinity of its component parts for each other, is readily reduced when mixed with chlorate of potash by contact with copper. This reduction is to a great extent surface only; when the metallic surface is amalgamated, further action ceases almost entirely."

In the case of brass the action is not confined to the surface, but penetrates the metal, rendering it porous and in time disintegrating it, requiring the use of varnish and tin foil between the fulminate and the brass.

For this reason, if for none other, it is well that a return to copper for the primer cup has been found to be practicable, and hereafter it is to be expected that there will be none of the leaks of gas incident to splits in forming the brass primer cup.

CASE.

In connection with the question of brittleness of cartridge case, after firing one round and retaining the case for a fixed period, due in all probability to some chemical or galvanic action if kept in moist places or if thrown into water, I must refer to my report of June 19, 1896, and to special report of September 21, 1896, recommending that the cartridge case manufactured here, and elsewhere if procured by contract, be accepted only as a first-class single-fire cartridge, and that its further function as a reloader must cease, except it may be by careful selection found to be suitable for the new blank with paper bullet.

In my report of June 19, 1896, it has been conclusively shown "by comparative tests, that the material used and methods of manufacture followed at this arsenal are equal, if not superior, to those of the best cartridge manufactories in this country" (see diagrams 1 to 7 of same report), and that brittleness with the fired cartridge case, after keeping, is less pronounced in the United States Frankford Arsenal product than in that of the private cartridge factories.

Later information (Paper A, report of September 21, 1896) shows that foreign cartridges tested are all rendered brittle after firing, when kept in water, and that the cartridge manufactured by private factories for the caliber .236 rifle, comes out of the gun in a brittle condition and can not therefore at once be successfully reloaded and fired a dozen or more rounds as is the case with the caliber .30 cartridge.

THE RIFLE AND CARBINE BLANK CARTRIDGE, WHOLE CASE, CALIBER .30, MODEL 1893.

(Plate III.)

For a blank cartridge to be used in the .30-caliber rifle or carbine for magazine firing, it must have practically the same form and dimensions as the ball cartridge, otherwise the magazine feed will not function properly.

The case for the "whole case," model 1893, blank cartridges, is made from annealed cartridge brass, such as is used for the .30-caliber ball-cartridge cases. The metal is obtained in strips 9 feet long, 2.3 inches wide, and must gauge between 0.079 and 0.081 inches for thickness. End angle of strips 63 degrees, to avoid waste in cupping.

The cups are cut out by a double-action press, such as used for the ball-cartridge case. The diameter of the disk is 1.2 inches; the diameter of the cup 0.8 inch, and the length of the cup 0.5 inch. The cup is drawn six times, and the first five draws are preceded by an annealing of the cups.

The successive stages of manufacture of the cases are exactly similar to those employed for the .30-caliber ball-cartridge cases, except that it is drawn to a greater length and given the tapering necessary to make it resemble in appearance and have approximately the same dimensions when completed as the .30-caliber ball cartridge. Tinning the cases is omitted.

The cases are trimmed to the proper length and primed with .45-caliber rifle primers, after which an operative, by means of a hand machine, cuts three angular notches in the mouth of the case of such dimensions that, when the points are folded in, comparatively tight joints will result and the end of the case have about the same form as the point of service bullet.

The cases are charged by hand, the charge used being 65 grains of black powder. After being charged, the points of the case are folded in by means of a hand machine designed for the purpose. The end of the cartridge is then dipped in a collodion varnish to make the joints waterproof.

This cartridge has been superseded by the paper-ball blank, model 1896, for the reason that it is known that gas leaking from a split or cracked primer is capable of igniting the powder charge in the blank, and in this manner induce a premature explosion of the blank in the magazine of the rifle. Exhaustive tests have shown that no such result can follow with the paper-bullet blank, the bullet being water-proofed and containing but 5 grains of E. C. smokeless powder.

Even when purposely exploded in the magazine these latter or paper-bullet blanks, with but 10 grains of powder, all told, fully confined, can do no damage to arm or firer.

PAPER-BULLET BLANK CARTRIDGES, MODEL 1896.

For the paper-bullet blank cartridges for the rifle and carbine, caliber .30, the case is the same in all respects as that used for the .30-caliber ball cartridges.[1]

The paper specially selected for the bullets is obtained in sheets 17 by 28 inches in size. These large sheets are cut into rectangular pieces 3$\frac{1}{16}$ by 7 inches, the proper dimensions to form, when rolled, four bullets. The tubes are rolled by hand, the operative using a smooth, slotted steel rod of proper length and diameter and turned in a semicircular groove in a board.

In rolling the tube a strip about half an inch in width along one of the longer edges of the paper is coated with glue.

The rod is cleaned and rubbed with lubricant and placed in the groove, and the long edge of the paper opposite the edge coated with the glue is inserted in the slot of the rod so that the glue edge will be on the inner side when the paper is rolled. The rod is then turned so as to roll the paper tightly and evenly about it, the outer edge being rubbed down smooth, the rubbing being continued until the edge has adhered firmly. A gauge is then slipped over the tube to find if it is of the proper diameter. Gauging properly, the tube is slipped from the rod and is ready to be cut into the proper lengths for bullets, i. e., 1$\frac{1}{16}$ inches. The diameter of the finished tube is 0.308 inch.

One operative can roll enough tubes for 2,000 bullets in one day.

The tubes having been cut into the proper lengths they are passed through a machine to form the bullet. The tubes are placed vertically in dies arranged in a horizontal carrier and are brought successively by it underneath the punch. The punch descending forces the tube into the die, diminishing the length of the tube and closing in the surplus length at the lower end to form a close, firm point to the bullet, and the die giving the proper taper and dimensions to the bullet. The punch is withdrawn on the return stroke, the bullet remaining in the die, which, in the next partial turn of the carrier, comes over the ejector which pushes the bullet upward and out of the die. The length of the finished bullet is 1½ inches.

For loading, the E. C. smokeless powder is used, 5 grains being compressed in the paper bullet to give the bullet the proper stiffness and insure its proper fragmentation on firing, while 5 more grains are placed in the powder chamber to insure the ignition of the powder in the bullet and to aid in giving a sufficiently loud report on firing. The bullets having been prepared, the cartridges are loaded on the loading machine in the same manner as the ball cartridges are loaded.

To prevent the paper bullets from being too susceptible to moisture, the bullet end of the cartridges are, after loading, dipped in melted paraffin which adheres to the paper and forms a smooth, firm coating on the bullets and thus enables them to withstand moisture for some time without injury.

The paper bullets are so made that the fragments shall not, on firing, penetrate a paper screen at 20 feet from the muzzle, and unless carelessly and needlessly exposed in service, it is believed that they will fulfill the expectations of the Department.

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[1] Fired cases are now being utilized for this purpose, although a percentage of brittle cases will enter the product in spite of the greatest precaution.

GALLERY-PRACTICE AMMUNITION.

Plate II.

To provide a suitable cartridge for gallery practice with the .30-caliber rifle, a case turned from a brass rod was first adopted. The exterior dimensions of this case are the same as those of the service case for the .30-caliber ball cartridge. The powder chamber is of a uniform diameter of 0.308 of an inch. A round bullet weighing 40 grains and consisting of 16 parts of lead to 1 of tin is used, the diameter of the bullet being the same as that of the powder chamber.

The firing charge is 5 grains of black powder, and good results have been obtained where no greater charge is employed, although the miniature chamber will contain as much as 20 grains of the same powder.

The latest and a much more economical form, known as the model 1896, consists simply of the regular service case for ball cartridges, with a cannelure rolled on its exterior at one-fourth of an inch from the mouth of the case to form a seat for the ball and prevent its falling or being forced too far into the neck of the case. A round ball of the same diameter and composition as that described for use with the turned case is used.

The firing charge consists of five grains of black powder, and the reduced density of loading over the miniature chamber model appears not to impair the accuracy.

General Orders, No. 23, Headquarters of the Army, Adjutant-General's Office, 1896, announced to the Army the change above referred to, prescribing the charge for gallery practice, and providing for the necessary steps to bring into use the new model shell after the old model shells on hand have been consumed.

In prescribing that the ball shall be simply inserted in the mouth of the case, and pressed down its full diameter only until flush with the mouth, it was hoped to correct a misapprehension existing in the service, that is, that it was necessary to ram or force the bullet down to the powder charge. In the new model case with the cannelure this operation is checked, but so long as the old model case remains in service the precaution should be heeded.

The poor practice with the round ball when 20 grains of powder was employed, as in the first instance, was due to the round lead ball being completely upset and acting as a slug, cutting across the lands and tumbling. This effect is not produced by the 5-grain powder charge.

CARTRIDGE PACKING BOX (PAPER).

The following changes have been made in the caliber .30 cartridge box to adapt it for use with the Bruce feed on the Gatling gun: The "comb" which was formerly $5\frac{1}{8}$ by $2\frac{7}{16}$ inches, with a slot $1\frac{1}{16}$ inches deep, is replaced by a "comb" $5\frac{1}{4}$ by $1\frac{7}{8}$ inches, with a slot $\frac{13}{16}$ inch. The "packing" has been changed from $2\frac{1}{8}$ by 1 inch (slot $1\frac{1}{16}$ inches) to $2\frac{15}{32}$ by 1 inch (slot, $1\frac{1}{16}$ inches).

In order to prevent the "packing" from working up or dropping out of place when the box is opened and inverted, the "comb" and "packing" are placed in the box in a reverse position from the old model, and the "comb" is glued to the ends of the box by means of two pieces of muslin 2 inches square, one piece on each end. The string which was formerly passed through from the inside of the top of cover and knotted on the inside to facilitate lifting of the cover is now run in from the end of cover, knotted on inside and wrapped about the end in such manner as to provide for the tearing out of the end of cover that the top may be slid off and not lifted from its place.

For this purpose the box is held in the left hand with end of string to right while the string is unwrapped, terminating with a jerk which tears out the end, and the cover is then slid off. In operating this box with the Bruce feed on the Gatling gun the lifting of the cover by the old method led to a displacement of some of the cartridges from the box as the operation was hastily performed.

CALIBER .22 CARTRIDGE.

Instructions were received from the Chief of Ordnance, dated January 4, 1895, directing that 250 cartridge shells and bullets, caliber .22, and 50 additional bullets be manufactured at this arsenal after a design prepared at the Springfield Armory for testing an experimental rifle of that caliber. Authority was given "to make any changes deemed essential in the construction as proposed to improve the design." It was then proposed, in accordance with the above provision for alteration of design, to increase the thickness of metal at the neck of the shell to the extent of 0.002 inch over and above the design from Springfield Armory, making it 0.013 inch instead of 0.011 inch. The object of this proposed change was to prevent the loss in manufacture by folding of the metal at the ends.

This change was assented to by the commanding officer Springfield Armory, and the cartridge case was then made after the original design except in this particular.

A drawing (Pl. V, herewith) of the cartridge manufactured was furnished with the sixth indorsement (O. O. file, No. 8563, dated August 23, 1895), "reporting issue of the following components of ammunition for experimental .22-caliber rifle: Two hundred and fifty cartridge shells, 300 bullets.

"Of the bullets, 250 weigh each 118 grains, 26 weigh 112 grains each, and 25, 120 grains each. The shells were not primed, as, it being the expressed purpose to experiment with various powders, it was thought that other primers than our present standard might be required for some of the more obdurate smokeless powders" (especially those of the nitrocellulose type, pure and simple, which were known to be employed in the smallest calibers).

At a later date the Peyton and W.-A. smokeless powders were furnished the Springfield Armory on a call for a suitable powder for experiment with the .22-caliber rifle, but it was stated that these powders were not known to be suitable for a lesser than the .30-caliber, as information had been obtained to the effect that nitrocellulose powders, free from the nitroglycerin, were best adapted for the smallest calibers, and that the granulation is special for each and every caliber.

In this connection the following table (VII) of computed elements of trajectories, etc., for the Army service and experimental bullets, employing Ingalls's formulas, is submitted.

Very respectfully,
J. P. FARLEY,
Lieutenant-Colonel, Ordnance Department, Commanding.

The CHIEF OF ORDNANCE, UNITED STATES ARMY,
Washington, D. C.

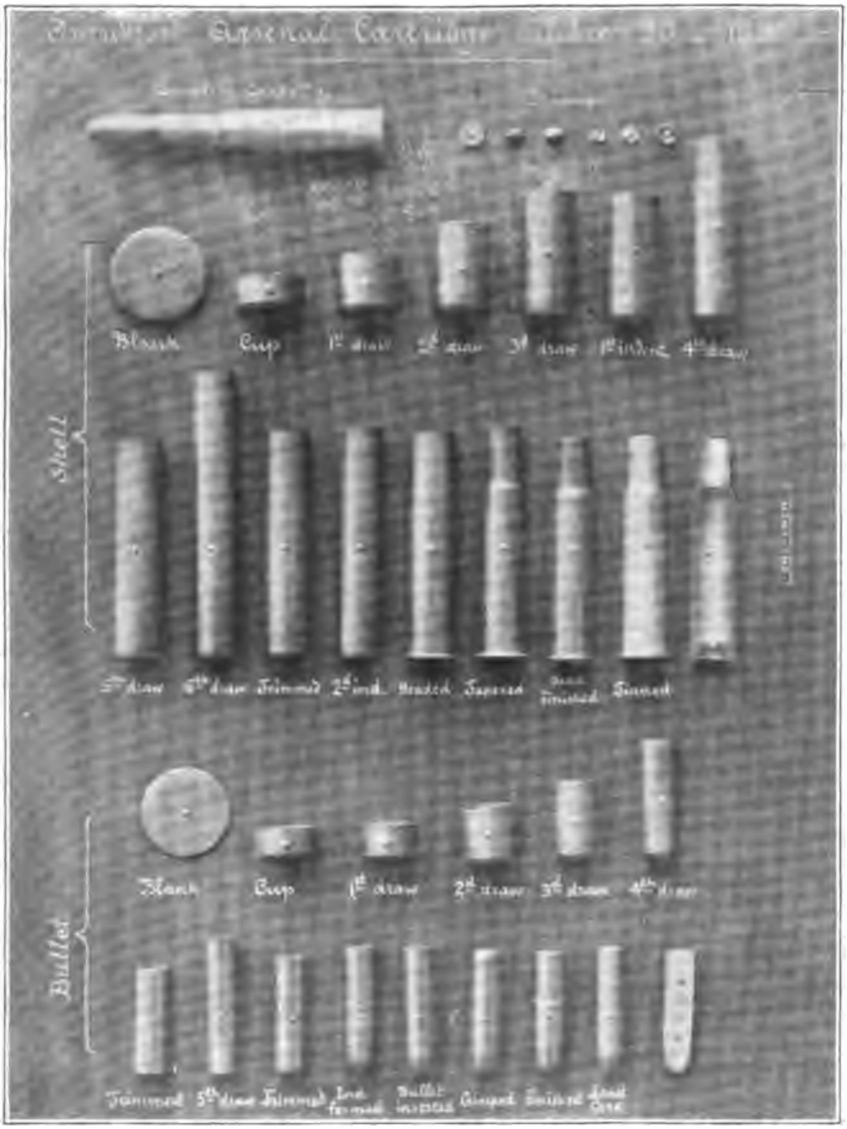
(10664)

TABLE VII.

Description of bullet.	Weight.	Diameter.	Sectional density.	Coefficient of reduction.	Ballistic coefficient.	Altitude factor for ballistic coefficient.	Range.	Muzzle and remaining velocity.	Angle of departure.	Angle of fall.	Time of flight.	Maximum ordinate.	Abscissa for maximum ordinate.	Maximum danger zone for infantry, in descending branch of trajectory.	Energy.	Energy per inch of circumference.
	Grains.	*Inch.*					*Feet.*	*Ft. per sec.*	° ′	° ′	*Seconds.*	*Feet.*	*Feet.*	*Feet.*	*Foot-lbs.*	*Foot-lbs.*
Army service bullet, caliber .30, cupro-nickeled steel jacket	220	0.30	0.3492	0.9	0.388	....	0	2,000.0	....	....	....	....	....	....	1,954.50	2,078.5
						0	2,640	901.8	1 15	2 05	2.13	18.79	1,495.1	172.04	397.37	420.65
						1.0036	5,280	599.5	4 19	8 19	5.77	145.00	3,041.0	*b* 39.34	175.61	186.33
						1.0145	7,920	407.6	10 08	22 18	11.25	550.94	4,731.8	*b* 14.02	81.17	86.13
						1.0218	*a* 9,042	347.9	14 02	31 45	14.41	907.68	5,496.5	*b* 9.31	59.14	62.75
Army experimental bullet, caliber .22, cupro-nickeled steel jacket.......	120	.22157	.3492	.9	.388	....	0	2,600.0	....	....	....	....	....	....	1,801.70	2,588.40
						0	2,640	1,032.6	0 46	1 25	1.70	12.06	1.524.0	275.25	284.10	408.27
						0	5,280	667.0	3 05	6 36	4.95	110.65	3,112.7	*b* 49.69	118.58	170.35
						1.0108	7,920	452.5	7 39	18 02	9.82	433.29	4,767.8	*b* 17.66	54.57	78.40
						1.0181	*a* 9,042	386.0	10 40	25 58	12.57	709.69	5,523.1	*b* 11.81	39.71	57.05
Army service bullet, caliber .45	500	.45227	.3492	1	.3492	1.0329	*a* 9,042	246.4	23 36	48 33	19.28	1,592.00	5,584.5	*b* 5.08	67.40	47.45

a Compare for range 9 042 feet (1.71 mile).

b Danger zone $= \dfrac{5.75 \text{ feet}}{\text{tan. angle of fall.}}$



Appendix 4, 1896.

PLATE II.

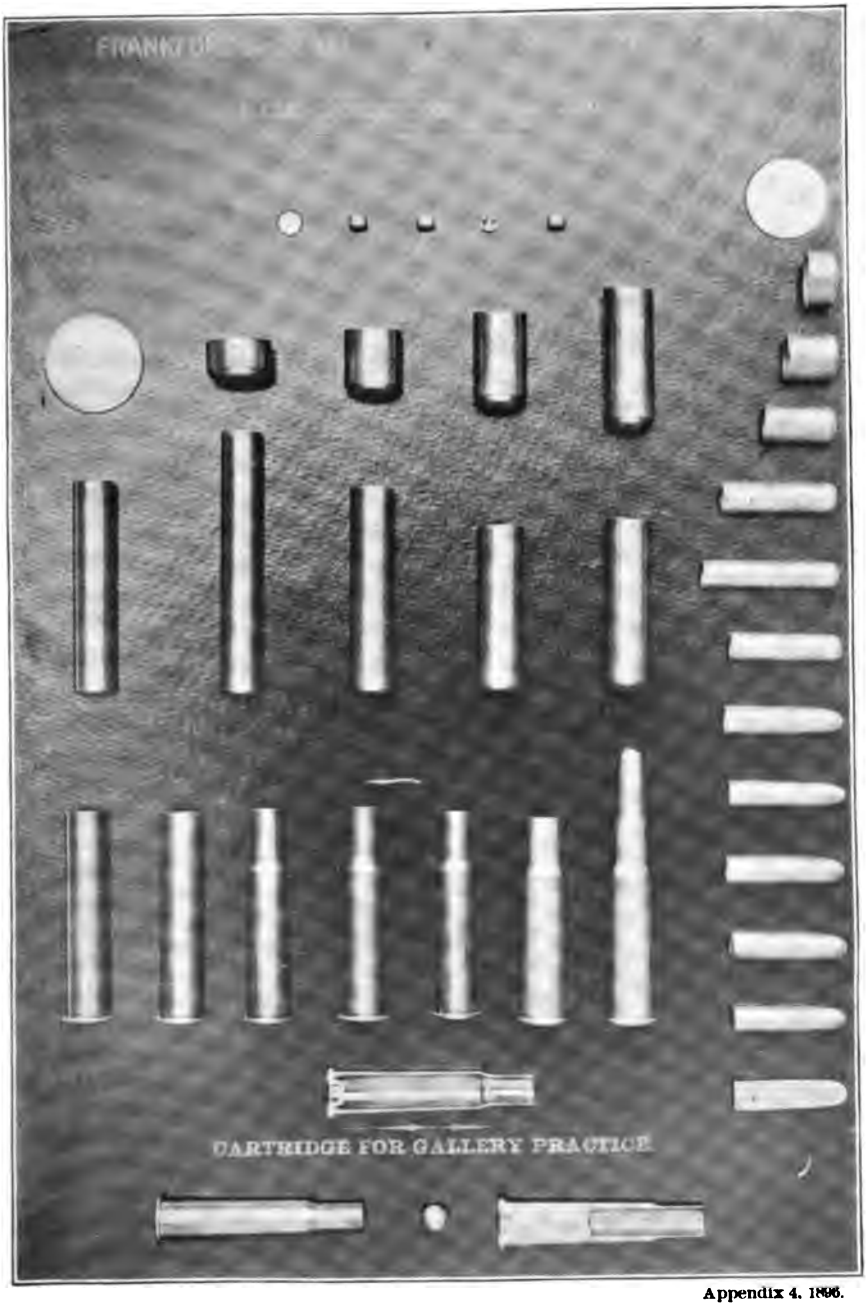
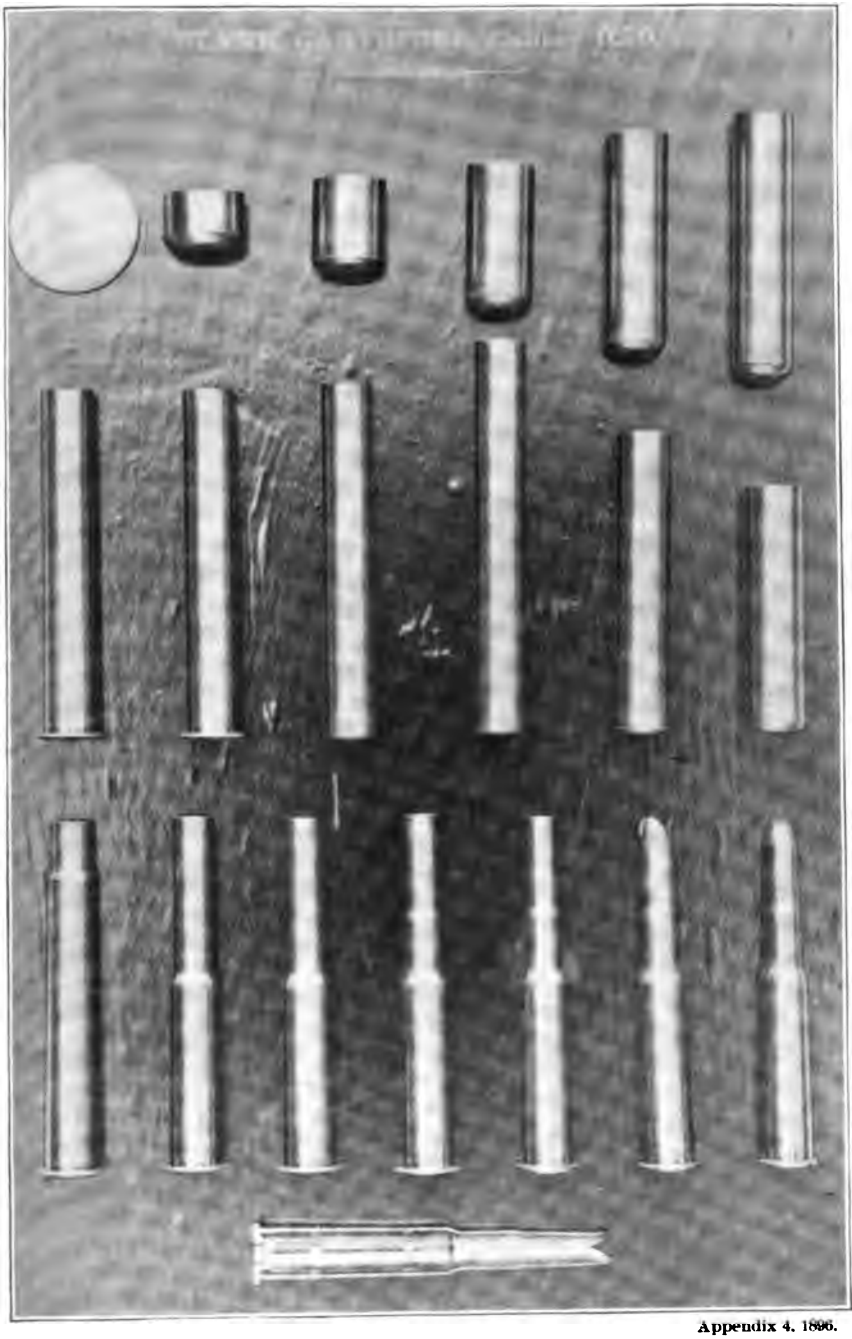
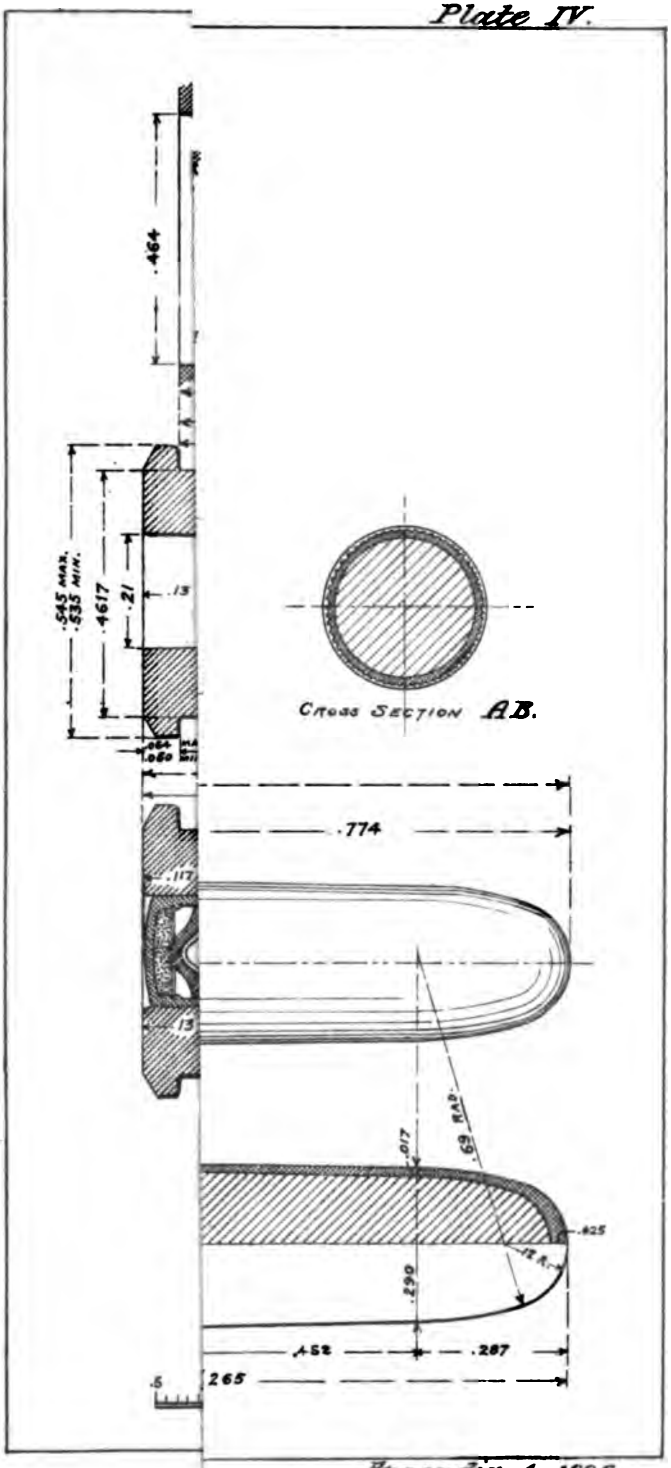


PLATE III.



Appendix 4. 1896.

Plate IV.

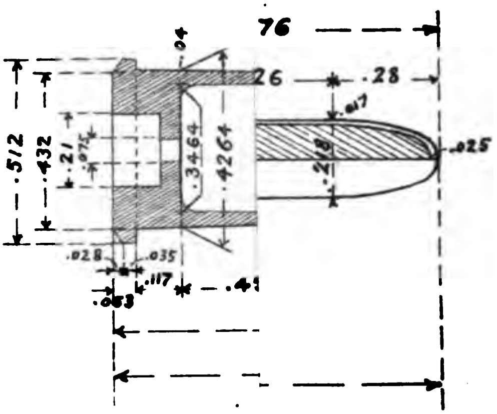


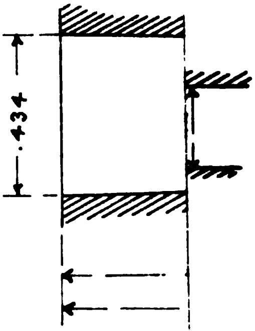
Appendix 4, 1896.

Ord 54 2

Plate V.

Frankford A

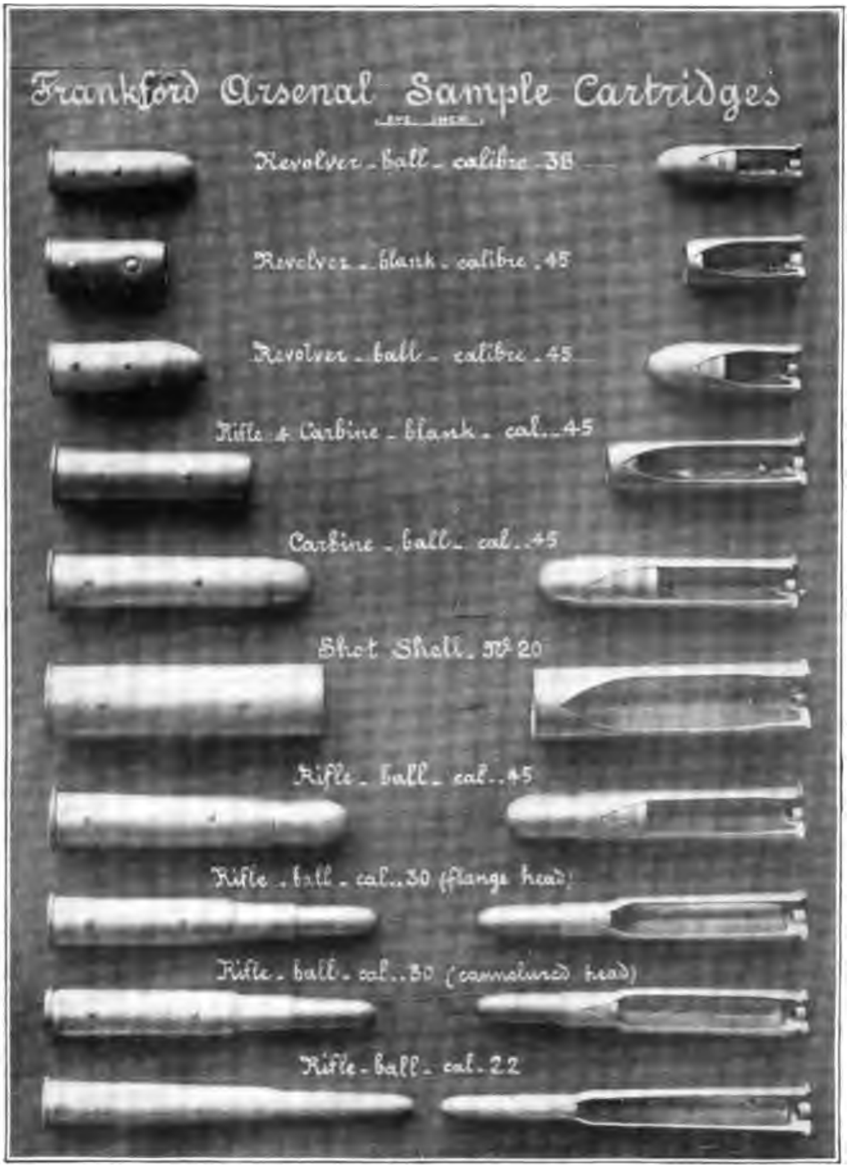




ndix 4, 1896.

Ord 54 2

PLATE VI.


Frankford Arsenal Sample Cartridges
Revolver _ ball _ calibre .38
Revolver _ blank _ calibre .45
Revolver _ ball _ calibre .45
Rifle & Carbine _ blank _ cal. .45
Carbine _ ball _ cal. .45
Shot Shell _ No 20
Rifle _ ball _ cal. .45
Rifle _ ball _ cal. .30 (flange head)
Rifle _ ball _ cal. .30 (cannelured head)
Rifle _ ball _ cal. 22

APPENDIX 5.

REPORT OF CHEMICAL LABORATORY AT FRANKFORD ARSENAL, FOR THE YEAR ENDING JUNE 30, 1896.

FRANKFORD ARSENAL,
Philadelphia, Pa., June 30, 1896.

SIR: I have the honor to submit the following report for the year ending June 30, 1896, of the principal operations at the chemical laboratory established at Frankford Arsenal for the purpose of investigating high explosives and smokeless powders.

The following smokeless powders have been received during the past year:

CANNON.

Maxim-Schüpphaus, for 12-inch rifle.
Maxim A[1], for 12-inch mortar.
Du Pont No. 1 (three samples), for 3.2-inch field guns.
Du Pont No. 2 (two samples), for 3.2-inch field guns.
Peyton, for 3.2-inch field guns.

FOR SMALL ARMS, .30 CALIBER.

Du Pont, 2,500 pounds, contract of June 6, 1895.
Peyton, 15,000 pounds, contract of May 31, 1895.
W.-A., smokeless, 3,000 pounds, contract of June 3, 1895.
Giant, two samples, designated A and B.
Giant, M 23 X.
Giant, J 10 X.
Martin Kalbfleisch.
Schüpphaus.
Volney, five samples.
Du Pont No. 1, for .45 caliber.

FOREIGN.

Kolfit, Germany.

The powders received under contract were examined as to their physical and chemical properties in the laboratory and as to their ballistic properties in the proof house, by the officer in charge of that branch. Many of the latter results are embodied with the laboratory tests in this report.

A number of the other samples have been examined to some extent.

PEYTON POWDER.

A general description of this powder has been given in the previous annual reports.

The following lots, from the California Powder Company, have been received and examined since June 30, 1895:

Lot.	Weight.	Date.	Lot.	Weight.	Date.
	Lbs.	1895.		*Lbs.*	1895.
1	1,000	July 18	9	1,000	July 18
2	1,000	July 18	10	1,000	July 18
3	1,000	July 18	11	1,000	Oct. 19
4	1,000	July 18	12	1,000	Oct. 19
5	1,000	July 18	13	1,000	Oct. 19
6	1,000	July 18	14	1,000	Oct. 19
7	1,000	July 18	15	900	Oct. 19
8	1,000	July 18	15*a*	100	Dec. 11

The general shape of the grains is that of a hexagonal prism, surface graphited and the interior of dark green color with yellow spots. Although apparently quite hard, it can be easily powdered in a mortar or ground in a mill. When first opening the bottle containing the powder, an odor of amyl acetate is perceptible.

The following percentages of the various sized grains were obtained by sifting 25 grams of this powder:

	+ 0.10.	+ 0.09.	+ 0.08.	+ 0.07.	+ 0.06.	+ 0.03.
Maximum	0.793 (11)	2.499 (11)	67.389 (11)	57.886 (8)	2.593 (1)	0.425 (1)
Minimum	0.242 (12)	0.843 (4)	38.237 (1)	28.052 (11)	1.262 (13)	0.180 (13)

The granulation (number of pieces per pound in + 0.07 lots 1 to 10, and + 0.08, lots 11 to 15) varied from 79054 (lot 15) to 98785 (lot 1). Specific gravity, 1.6483 (13) to 1.6384 (4). Gravimetric density, 934 (1) to 948 (13). Residue remaining after flashing on a glass plate, 2.24 per cent (6) to 2.56 per cent (4). Stability, 15 minutes (3) to 38 minutes (9).

In order to obtain more uniform ballistic results, the weight of charge used in the different lots was varied as follows:

Charge: 35 grains, lots 4 and 5.
Charge: 35.1 grains, lot 1.
Charge: 35.5 grains, lots 2, 3, 6, 7, 8, 9, 10, and 14.
Charge: 36 grains, lots 11, 12, 13, and 15.

The temperature of the bore (just in front of the chamber) was increased 108° F. by firing 25 rounds in 57½ seconds.

The effect of exposure of Peyton No. 26 (contract 1894–95) and of Peyton No. 4 (contract 1895–96) will be mentioned later.

With the U. S. magazine rifle, caliber .30, a 220-grain cupro-nickel-steel jacketed bullet, and the varying charges, the following velocities (at 53 feet) and pressures were obtained:

[The figures in parentheses refer to the number of the lot.]

Charge.	Average velocity obtained.			Average mean variation.			Average pressure obtained per square inch.			Number of lot.
	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	
	Feet per sec.	*Feet per sec.*	*Feet per sec.*	*Feet.*	*Feet.*	*Feet.*	*Pounds.*	*Pounds.*	*Pounds.*	
35 grains	1,945.5 (4)	1,946.7	1,948 (5)	10.28 (4)	11.09	11.90 (5)	34,648 (5)	36,277	37,907 (4)	4, 5.
35.1 grains		1,959.9			10.39			35,077		1.
35.5 grains	1,953.7 (14)	1,966.7	1,973.6 (10)	8.61 (14)	11.15	13.19 (6)	33,403 (9)	36,233	37,846 (10)	2, 3, 6, 7, 8, 9, 10, 14.
36 grains	1,958.4 (15)	1,950.8	1,963.6 (12)	9.15 (12)	10.88	12.98 (13)	35,137 (11)	36,200	38,618 (13)	11, 12, 13, 15.

The average maximum and minimum given are those of at least 50 shots in the lots noted. The average mean is the mean of the averages of each lot.

Average changes in velocity, pressure, and weight of the several lots of Peyton powder (compared with original powder fired at the same time) caused by the various tests.

[Heat: 130° for 24 hours.]

POWDER.

Charge.	Increase in velocity.			Increase in pressure per square inch.			Loss in weight.			Number of lot.
	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	
	Feet.	*Feet.*	*Feet.*	*Pounds.*	*Pounds.*	*Pounds.*	*Per cent.*	*Per cent.*	*Per cent.*	
35 grains	+7 (5)		+32 (4)	887 (4)		2,748 (5)	0.5463 (4)		0.5643 (5)	4, 5.
35.1 grains		+51(1)			67(1)			0.6072		1.
35.5 grains	27 (7)	39.37	64 (14)	2,000 (3)	3,880	5,540 (8)	.5122 (9)	.5676	.6286 (14)	2, 3, 6, 7, 8, 9, 10, 14.
36 grains	54 (11)	58	63 (13)	3,680 (11)	4,560	5,870 (12)	.6085 (15)	.6511	.6805 (13)	11, 12, 13, 15.

CARTRIDGES.

Charge.	Increase in velocity.			Increase in pressure per square inch.			Loss in weight.			Number of lot.
	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	
35 grains	52 (4)		62 (5)	2,430 (4)		4,560 (5)				4, 5.
35.1 grains		50			(*a*)					1.
35.5 grains	40 (6)	56.5	93 (14)	*a* 620 (2)	4,077	9,570 (14)				2, 3, 6, 7, 8, 9, 10, 14.
36 grains	89 (15)	108	126 (13)	3,940 (11)	10,716	13,550 (13)				11, 12, 13, 15.

a No. 1 lost 4,720 pounds; No. 3 lost 4,680 pounds.

Average changes in velocity, pressure, and weight of the several lots of Peyton powder, etc.—Continued.

[Moisture: Saturated atmosphere for 24 hours.]

POWDER.

Charge.	Decrease in velocity.			Decrease in pressure per square inch.			Gain in weight.			Number of lot.
	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	
	Feet per sec.	*Feet per sec.*	*Feet per sec.*	*Pounds.*	*Pounds.*	*Pounds.*	*Per cent.*	*Per cent.*	*Per cent.*	
35 grains	112 (5)		128 (4)	3,240 (5)		4,680 (4)	1.655 (4)		1.849 (5)	4, 5.
35.1 grains		148			1,038			1.449		1.
35.5 grains	104 (6)	154	199 (8)	500 (3)	4,347	8,470 (10)	1.354 (14)	1.651	1.921 (8)	2, 3, 6, 7, 8, 9, 10, 14.
36 grains	117 (15)	130	144 (11)	4,880 (12)	6,835	8,580 (13)	1.054 (15)	1.190	1.294 (13)	11, 12, 13, 15.

[In saturated atmosphere for one week.]

CARTRIDGES.

35 grains	9 (5)		14 (4)	1,730 (5)		3,540 (4)				4, 5.
35.1 grains		17			1,380					1.
35.5 grains	1 (6)	*a* 8.66	22 (8)	100 (6)	*b* 670	1,800 (7)				2, 3, 6, 7, 8, 9, 10, 14.
36 grains	1 (13)	(*a*)	12 (12)	2,490 (15)	3,000	4,253 (13)				11, 12, 13, 15.

a Lot 11 gained 7 feet; lot 14 gained 7 feet; lot 15 gained 7 feet.
b Lot 2, no change in pressure; lot 3 increased 1,270 pounds per square inch.

[Moisture and air: Saturated atmosphere 24 hours, then in the open air for 24 hours.]

POWDER.

Charge.	Decrease in velocity.			Decrease in pressure per square inch.			Gain in weight.			Number of lot.
	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	
	Feet.	*Feet.*	*Feet.*	*Pounds.*	*Pounds.*	*Pounds.*	*Per cent.*	*Per cent.*	*Per cent.*	
35 grains	17 (5)		26 (4)	2,450 (4)		380 (5)	0.336 (5)		0.386 (4)	4, 5.
35.1 grains		10			2,000			0.053		1.
35.5 grains	12 (2–14)	15.4	21 (9)	410 (10)	*a* 1,528	3,030 (3)	.019 (10)	.131	.385 (6)	2, 3, 6, 7, 8, 9, 10, 14.
36 grains	4 (11)	(*b*)	4 (12)	740 (13)	*a* 1,660	*a* 2,510 (11)	*c* .100 (12)	*c* .173	*c* .252 (15)	11, 12, 13, 15.

a Lot 7 gained 360 pounds; lot 8 gained 770 pounds; lot 9 gained 1,210 pounds in pressure.
b Lot 7 gained 3 feet; lot 15 gained 15 feet; lot 13, no change in velocity.
c Lot 14 lost 0.156 per cent in weight.

[Air: In the open air for 24 hours.]

POWDER.

Charge.	Change in velocity.			Change in pressure per square inch.			Change in weight.			Number of lot.
	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	
	Feet per sec.	*Feet per sec.*	*Feet per sec.*	*Pounds.*	*Pounds.*	*Pounds.*	*Per cent.*	*Per cent.*	*Per cent.*	
35 grains	+ 2 (5)		+12 (4)	— 210 (4)		+2, 800 (5)	+0. 057 (5)		—0. 069 (4)	4. 5.
35.1 grains		—17			—1, 210			—0. 008		1.
35.5 grains	0 (14)	+ 2. 2	+ 6 (7)	— 270 (3)	— 926	—1, 820 (2)	+ . 028 (3)	+ . 123	+ . 263 (10)	2, 3, 6, 7, 8, 9, 10, 14.
36 grains	+10 (11)	+12	+17 (13)	+1, 230 (11)	+1, 473	+1, 960 (13)	— . 130 (15)	— . 193	— . 265 (11)	11, 12, 13, 15.

Lost in velocity: Lot 3, 3 feet; lot 8, 4 feet; lot 10, 19 feet; lot 15, 8 feet.
Gained in pressure: Lot 6, 2,980 pounds; lot 8, 2,940 pounds; lot 9, 2,360 pounds; lot 15 lost 400 pounds.
Lost in weight: Lot 6, 0.076 per cent; lot 14, 0.082 per cent.

[Lot No. 1: Cold, 40° F. for 6 hours.]

	Loss in velocity.	Loss in pressure per square inch.	Gain in weight.
	Feet per sec.	*Pounds.*	*Per cent.*
Powder	11	2, 810	0. 048
Cartridges	a 53	5, 000	

a Mean variation in velocity changed from 9.36 feet to 16.67 feet. The cartridges were fired while cold. There was one hang-fire.

W.-A. SMOKELESS POWDER.

This powder was received from the American Smokeless Powder Company, under contract dated June 3, 1895, as follows:

Lot.	Weight.	Date.
	Pounds.	1895.
1	1,000	July 19.
2	1,000	Sept. 7.
3	1,000	Sept. 7.

The general shape of the grains is cylindrical, of a dark lemon color, somewhat lighter at the edges. The length varies from 0.060 to 0.070 inch, and the diameter is about 0.050 inch (+ 03).

They are hard, but not brittle, and when the bottle is first opened, a strong odor of acetone is noticeable.

The following percentages of the various sized grains were obtained by sifting 25 grams of this powder:

	+0.10.	+0.09.	+0.08.	+0.07.	+0.06.	+0.03.
Maximum	0.400 (2)	0.246 (3)	1.254 (1)	1.76 (3)	38.114 (3)	86.555 (1)
Minimum	0.154 (3)	0.060 (4)	0.568 (3)	0.828 (1)	10.966 (1)	59.170 (3)

The granulation varied from 142960 (3) to 134660 (1). Specific gravity varied from 1.787 (1) to 1.790 (2). Gravimetric density varied from 988 (3) to 1049 (1). Residue remaining after flashing on a glass plate, from 9.584 per cent (1) to 13.120 per cent (3). Stability, 23 minutes (3) to 30 minutes (1).

With the U. S. magazine rifle, a 220-grain cupro-nickel-steel jacketed bullet, and the varying charges, the following results were obtained:

Charge.	Mean standard velocity.	Variation from standard.		Pressure, standard, per square inch.			Lot.
		Mean.	Extreme.	Mean.	Extreme.	Ext. tests.	
	Feet.			*Pounds.*	*Pounds.*	*Pounds.*	
43 grains	1974.8	8.49	48	33,880	38,330	42,150	1
41.5 grains	1947.9	8.70	49	33,780	36,100	42,350	2
42 grains	1953.7	10.26	42	35,520	39,750	43,150	3

The temperature of the bore (just in front of the chamber) was increased 142° F. by firing 25 rounds in 60 seconds.

The changes in velocity, pressure, and weight of W.-A. powder (as compared with the original powder fired at the same time) caused by the various tests is shown in the following tables:

[Heat: 130° for 24 hours.]

	Change in velocity.	Change in pressure per square inch.	Change in weight.	Charge.
POWDER.	*Feet.*	*Pounds.*	*Per cent.*	*Grains.*
Leonard W.-A., No. 1	+ 23	+ 3,150	— 0.596	43
Leonard W.-A., No. 2	+ 32	+ 5,130	— 0.466	41.5
Leonard W.-A., No. 3	+ 49	— 1,400	— 0.525	42
CARTRIDGES.				
Leonard W.-A., No. 1 [a]	+ 47	+ 1,840		43
Leonard W.-A., No. 2	+ 37	+ 7,730		41.5
Leonard W.-A., No. 3	+ 41	+ 5,780		42

[a] Fired while hot.

[Moisture: Saturated atmosphere for 24 hours.]

	Change in velocity.	Change in pressure per square inch.	Change in weight.	Charge.
POWDER.	*Feet.*	*Pounds.*	*Per cent.*	*Grains.*
Leonard W.-A., No. 1	— 58	— 30	+1.954	43
Leonard W.-A., No. 2	—121	— 750	+1.249	41.5
Leonard W.-A., No. 3	— 90	—6,200	+1.146	42
CARTRIDGES.				
Leonard W.-A., No. 1 *a*	— 3	—2,804	....	43
Leonard W.-A., No. 2	— 56	—1,680	....	41.5
Leonard W.-A., No. 3	— 12	—2,370	....	42

a Exposed 1 week.

[Moisture and air: Saturated atmosphere 24 hours, then exposed to air for 24 hours.]

Powder.	Change in velocity.	Change in pressure per square inch.	Change in weight.	Charge.	Moisture in air.
	Feet.	*Pounds.*	*Per cent.*	*Grains.*	*Per cent.*
Leonard W.-A., No. 1	+25	+5,670	+0.1305	43	84–95
Leonard W.-A., No. 2	—26	— 320	+0.153	41.5	79–85
Leonard W.-A., No. 3	— 1	+ 470	+0.059	42	79–85

[Air: Exposed on a glass plate for 24 hours.]

Leonard W.-A., No. 1	+14	+2,350	+0.183	43	75–83
Leonard W.-A., No. 2	—13	+ 830	+0.017	41.5	83–88
Leonard W.-A., No. 3	— 8	+5,670	+0.020	42	83–88

[Cold: 40° F. for 6 hours.]

	Change in velocity.	Change in pressure per square inch.	Change in weight.	Charge.
POWDER.	*Feet.*	*Pounds.*	*Per cent.*	*Grains.*
Leonard W.-A., No. 1	+13	+2,060	+0.009	43
CARTRIDGE.				
Leonard W.-A., No. 1 *a*	—19	—4,050	....	43

a Fired while cold.

DU PONT POWDER.

This powder was received under contract dated June 3, 1895, from E. I. Du Pont & Co., in the following lots:

Lot.	Weight.	Date.
	Pounds.	1895.
1	1,000	July 10
2	1,000	Nov. 29
3	500	Nov. 29

The grain is cylindrical in shape, about 0.050 inch in diameter and 0.054 inch to 0.064 inch in length. The surface, though covered with graphite, has a dark green tinge. The interior is dark green in color with yellow spots. It is quite hard and rather tough.

The following percentages of the various sized grains were obtained by sifting 25 grams of this powder:

	+0.10.	+0.09.	+0.08.	+0.07.	+0.06.	+0.03.	—0.03.
Maximum...	0.428 (3)	0.849 (2)	2.036 (1)	68.239 (2)	71.852 (1)	0.404 (1)	0.010 (1)
Minimum....	0.072 (1)	0.378 (1)	1.592 (2)	25.498 (1)	28.857 (2)	0.154 (3)	0.006 (3)

Granulation varied from 106540 (3) to 105800 (1). Specific gravity varied from 1.630 (2) to 1.633 (1). Gravimetric density varied from 935 (2 and 3) to 973 (1). Residue from flashing, 2.640 per cent (3) to 2.744 per cent (1). Stability, 16 minutes (1) to 54 minutes (2).

With the U. S. magazine rifle, a 220-grain cupro-nickel-steel jacketed bullet, and the varying charges, the following results were obtained:

Charge.	Mean standard velocity.	Variation from standard.		Pressure, standard, per square inch.			Lot.
		Mean.	Extreme.	Mean.	Extreme.	Extreme tests.	
	Feet.			*Pounds.*	*Pounds.*	*Pounds.*	
38.5 grains...	1,960	8.50	52	34,400	41,400	41,800	1
36 grains.....	1,952	10.88	55	32,680	33,250	36,250	2
36 grains.....	1,955.9	14.2	61	33,600	35,560	41,350	3

The temperature of the bore just in front of the chamber was increased 119° F. by firing 25 rounds in sixty seconds.

The changes in velocity, pressure, and weight of the Du Pont powder, as compared with the original powder fired at the same time, are shown in the following tables:

[Heat: 130° for 24 hours.]

	Change in velocity.	Change in pressure per square inch.	Change in weight.	Charge.
POWDER.				
	Feet.	*Pounds.*	*Per cent.*	*Grains.*
Du Pont No. 1	+23	— 10	—0.386	38.5
Du Pont No. 2	+33	+ 140	—0.408	36
Du Pont No. 3	+13	—2,870	—0.370	36
CARTRIDGES.				
Du Pont No. 1*a*	+21	— 440	....	38.5
Du Pont No. 2	+20	+ 510	....	36
Du Pont No. 3	+ 9	—2,410	....	36

a Fired while hot.

[Moisture: Saturated atmosphere for 24 hours.]

	Change in velocity.	Change in pressure per square inch.	Change in weight.	Charge.
POWDER.				
	Feet.	*Pounds.*	*Per cent.*	*Grains.*
Du Pont No. 1	— 50	—5,590	+1.145	38.5
Du Pont No. 2	—117	—2,940	+0.925	36
Du Pont No. 3	—123	—5,320	+0.958	36
CARTRIDGES.				
Du Pont No. 1	— 12	(*a*)	....	38.5
Du Pont No. 2	— 10	—2,960	....	36
Du Pont No. 3	— 9	+2,130	....	36

a Uncertain. No change from initial compression of 29,900 pounds.

[Moisture and air: Saturated atmosphere 24 hours, then exposed to air for 24 hours.]

Powder.	Change in velocity.	Change in pressure per square inch.	Change in weight.	Charge.
	Feet.	*Pounds.*	*Per cent.*	*Grains.*
Du Pont No. 1	+ 4	—1,980	+0.163	38.5
Du Pont No. 2	+ 4	— 900	—0.102	36
Du Pont No. 3	+ 4	+ 230	—0.100	36

[Air: In the open air for 24 hours.]

Powder.	Change in velocity.	Change in pressure per square inch.	Change in weight.	Charge.	Moisture in air.
	Feet.	*Pounds.*	*Per cent.*	*Grains.*	*Per cent.*
Du Pont No. 1	....	—1,110	+0.105	38.5	75 to 83
Du Pont No. 2	+18	— 880	—0.115	36	63 to 75
Du Pont No. 3	— 7	+ 290	—0.062	36	63 to 75

[Cold: 40° F. for 6 hours.]

	Change in velocity.	Change in pressure per square inch.	Change in weight.	Charge.
POWDER.	*Feet.*	*Pounds.*	*Per cent.*	*Grains.*
Du Pont No. 1	+11	— 893	+0.063	38.5
CARTRIDGES.				
Du Pont No. 1[a]	—24	—8,260	....	38.5

[a] Fired while cold.

GIANT POWDER.

This powder was made by the Giant Powder Company, California. Several samples were received here for examination, as follows:

Giant, M 23 X, December 31, 1895.
Giant, J 10 X, January 9, 1896.
Giant, A, January 9, 1896.
Giant, B, February 13, 1896.[1]

A and B were designations given at the laboratory.

The grains are cylindrical in form, those from A being 0.086 to 0.093 inch long by 0.076 to 0.082 inch in diameter; those from B 0.073 to 0.099 inch in length by 0.066 to 0.075 inch in diameter.

They are sufficiently soft to be cut with the finger nail. The exterior surface is covered with graphite and the interior is of a dark color with a few whitish spots. There is a slight odor perceptible.

The general size of the grain is as follows:

	+.10.	+.09.	+.08.	+.07.	+.06.
Giant A	4.952	50.256	42.388	2.404	....
Giant B	2.594	21.130	57.013	18.692	0.568

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[1] Powder for .45-caliber rifles and Gatling guns, as stated by the Giant Powder Company, February 4, 1896.

Granulation: A, 41830; B, 5390. Specific gravity: A, 1.625; B, 1.655. Gravimetric density: A, 960; B, 952. Residue remaining after flashing on glass plate: A, 2.20 per cent; B, 3.840 per cent. Stability: A, 55 to 81 minutes; B, 30 to 41 minutes; M 23 X, 26 minutes; J 10 X, 27 minutes.

With the U. S. magazine rifle, a 220-grain cupro-nickel-steel jacketed bullet, and the varying charges the following results were obtained:

Powder.	Mean standard velocity.	Variations from standard.		Pressure, standard, per square inch.		Charge.
		Mean.	Extreme.	Mean.	Extreme.	
	Feet.			*Pounds.*	*Pounds.*	*Grains.*
Giant A	1,932.6	22.6	113	41,230	45,000	40
Giant B	1,954.4	20.59	82	35,200	37,100	38

The changes in velocity, pressure, and weight of the Giant powders (as compared with the original powder fired at the same time) caused by the various tests are shown in the following tables:

[Heat: 130° for 24 hours.]

	Change in velocity.	Change in pressure per square inch.	Change in weight.	Charge.
POWDER.				
	Feet.	*Pounds.*	*Per cent.*	*Grains.*
Giant A	+ 45	+1,870	—0.415	40
Giant B	+144	+1,790	—0.484	38
CARTRIDGES.				
Giant A[a]	+ 87	+ 710	....	40
Giant B	— 1	— 250	....	38
Giant J 10 X	+ 17	—2490	....	36

[a] Fired while hot.

[Moisture: Saturated atmosphere for 24 hours.]

POWDER.				
Giant A	— 46	—2,000	+0.338	40
Giant B	—187	—6,740	+1.221	38
CARTRIDGES.				
Giant A	+ 21	—2,790	....	40
Giant B	+ 19	+3,500	....	38

[Moisture and air: Saturated atmosphere 24 hours; then exposed to air for 24 hours.]

Powder.	Change in velocity.	Change in pressure per square inch.	Change in weight.	Charge.	Moisture in air.
	Feet.	*Pounds.*	*Per cent.*	*Grains.*	*Per cent.*
Giant A	—10	+2,280	—0.205	40	71 to 75
Giant B	—12	+ 480	— .081	38	53 to 59
Giant J 10 X[a]	—23	—2,520	— .111	36	69 to 71
Giant M 23 X[a]	—25	+1,160	— .133	32	69 to 71

[a] Gained from moisture test: J 10 X, +0.916 per cent; M 23 X, +0.915 per cent.

[Air: Exposed loose to air for 24 hours.]

Giant A	+22	+3,310	—0.207	40	71 to 75
Giant B	+14	+2,738	— .050	38	53 to 59

[Cold: Exposed to 40° F. for 6 hours.]

Cartridges.	Change in velocity.	Change in pressure per square inch.	Change in weight.	Charge.
	Feet.	*Pounds.*	*Per cent.*	*Grains.*
Giant A *a*	+ 55	+8, 230	....	40
Giant A	+ 51	+ 250	....	40
Giant B	+100	+3, 290	....	38

a Fired while cold.

[Cold and air: After freezing, exposed to air for 24 hours.]

Powder.	Change in velocity.	Change in pressure per square inch.	Change in weight.		Charge.	Moisture in air.
			From air.	From cold		
	Feet.	*Pounds.*	*Per cent.*	*Per cent.*	*Grains.*	*Per cent.*
Giant A	+ 38	—1, 440	—0. 045	—0. 063	40	*a* 55 to 72
Giant B	— 7	—4, 030	— . 095	— . 006	38	*b* 32 to 66

a Four periods of 6 hours. *b* Six hours.

In order to determine the effect of exposure on powder (in the cartridge case), machine-loaded cartridges were exposed in open shallow boxes on the southern slope of the roof of the chemical laboratory. They were placed in an inclined position, bullet end down; the upper end supported by grooved cleats, the lower resting on strips of glass.

Duplicate cartridges, in the original pasteboard boxes, were retained in the laboratory as standards.

At certain periods, twenty cartridges (each of exposed and standard) were examined as follows:

The powder was removed from ten, two portions of which were tested for stability, the remainder subjected for twenty-four hours to a temperature of 130° F. (heat test) and loss of weight noted. In several cases this powder was afterwards examined for velocity and pressure. The remaining cartridges were fired for velocity.

The following powders were treated in this manner:

Peyton, lot 26: Received February 5, 1895. April 25, 1895, to June 25, 1896—fourteen months.

Leonard, lot 3: Received April 3, 1895. July 17, 1895, to June 17, 1896—eleven months.

Du Pont, lot 1: Received July 10, 1895. October 1, 1895, to July 1, 1896—nine months.

Peyton, lot 4: Received July 18, 1895. October 1, 1895, to July 1, 1896—nine months.

W.-A., lot 1: Received July 19, 1895. October 1, 1895, to July 1, 1896—nine months.

The general effect on the exterior was to roughen the surface of the case, giving it a dull, brassy appearance, with numerous black spots. In some instances the neck of the case was cracked longitudinally. The bullet, except where covered by the case, became of a dark copper color, with raised portions of rust. This change was, in my opinion, caused, to a great extent, by the vapors from the acid works in the vicinity, as bullets have been kept in an atmosphere saturated with moisture for nearly a year without showing the slightest rust.

The interior of the case was not injured by the contact of the powder.

The bullet used in these tests was cupro-nickel-steel jacketed, weighing 220 grains.

ROOF EXPOSURE.

[Peyton, lot 26: Received February 5, 1895.]

Loaded April 17, 1895, with 36.6-grain charge, E_{36} primer and 0.08-inch metal case. Velocity when loaded 1,982 feet. When originally tested the stability was 20 minutes, and the loss by heat test was 1.059 per cent.

Date of removal.	Time exposed.	Exposed.			Standard.			After heat test.			
								Exposed.		Standard.	
		Velocity.	Stability.	Loss, heat test.	Velocity.	Stability.	Loss, heat test.	Velocity.	Pressure.	Velocity.	Pressure.
1895.	*Mos.*			*Per ct.*			*Per ct.*				
June 25.	2	1,975	23	1.305	1,989	30 to 35	1.092	....	....	....	....
Sept. 17.	$4\frac{27}{30}$	2,012.7	23	.894	2,006	47 to 52	1.072	....	....	....	....
Dec. 16..	$7\frac{27}{30}$	1,950.6	16 to 18	1.470	1,982.4	36	1.305	....	....	....	....
1896.											
Mar. 16.	$10\frac{27}{30}$	1,946	44 to 53	1.288	1,985.6	35	1.229	2,137.6	48,700	....	....
June 25.	14	1,957	80 to 90	.381	1,984.4	38	1.697	2,074	47,850	2,053	50,000

There were several hang-fires during the examination of December 16, and one velocity of 1,786 feet. From this date the stability increases and the volatile ingredients have become reduced.

[Leonard, lot 3: Received April 3, 1895.]

Loaded July 15 with 36.2-grain charge, $F_{.35}$ primer and 0.03-inch metal case. Velocity when loaded, 1,964 feet. Stability, 60 minutes. Loss by heat test, 0.240 per cent.

[Exposed July 17, 1895. Test still in progress.]

Date of removal.	Time exposed.	Exposed.			Standard.			After heat test.			
								Exposed.		Standard.	
		Velocity.	Stability.	Loss, heat test.	Velocity.	Stability.	Loss, heat test.	Velocity.	Pressure.	Velocity.	Pressure.
1895.	*Mos.*			*Per ct.*			*Per ct.*				
Sept. 17.	2	1,930	Above 60	0.473	1,938	47 to 57	0.272	....	....	....	....
Dec. 17..	5	1,884.2	Above 60	.601	[a]1,922.5	Above 60	.455	....	....	....	....
1896.											
Mar. 17.	8	1,895.4	Above 60	.669	1,958.5	Above 60	.380	1,971.2	31,150	....	....
June 17.	11	1,861.3	56 to 68	.875	1,922.3	56	.453	1,978	34,400	1,972	35,600

[a] Average of 7 shots: Two shots had 1,886 and one 1,858 feet velocity.

This powder does not appear to have been permanently injured by the exposure, and the reduced velocity is due to a great extent to the absorbed moisture.

[Du Pont, lot 1: Received July 10, 1895.]

Loaded September 28 with 37.5-grain charge, $E_{.36}$ primer and 0.12-inch metal case. Velocity when loaded, 1,967 feet. Stability, 19 to 22 minutes. Loss by heat test, 0.386 per cent.

[Exposed October 1, 1895. Test still in progress.]

Date of removal.	Time exposed.	Exposed.			Standard.			After heat test.			
								Exposed.		Standard.	
		Velocity.	Stability.	Loss, heat test.	Velocity.	Stability.	Loss, heat test.	Velocity.	Pressure.	Velocity.	Pressure.
1896.	Mos.			Per ct.			Per ct.				
Jan. 2...	3	1,778	30 to 33	1.586	1,957.4	30 to 33	0.485	....	....	....	....
Apr. 1..	6	a1,887.4	28½	.520	1,966	36 to 44	.465	1,913	30,200	....	....
July 1..	9	1,861.2	57	.791	1,971.2	24	.430	1,926.7	31,900	1,932.8	32,350

a Average of 9 shots, as one primer failed to ignite powder.

[Peyton, lot 4: Received July 18, 1895.]

Loaded September 27 with 34.6-grain charge, $E_{.36}$ primer and 0.12-inch metal case. Velocity when loaded, 1,957.3 feet. Stability, 20 to 27 minutes. Loss by heat test, 0.546 per cent.

[Exposed October 1, 1895. Test still in progress.]

Date of removal.	Time exposed.	Exposed.			Standard.			After heat test.			
								Exposed.		Standard.	
		Velocity.	Stability.	Loss, heat test.	Velocity.	Stability.	Loss, heat test.	Velocity.	Pressure.	Velocity.	Pressure.
1896	Mos.			Per ct.			Per ct.				
Jan. 2...	3	1,759.8	14 to 16	1.975	1,945.9	43	0.654	....	....	....	....
Apr. 1...	6	1,858.9	33½	.696	1,966.4	49 to 51	.690	1,946	34,300	....	....
July 1...	9	1,756.5	53	.726	1,905.2	28 to 38	.572	2,030	43,600	1,963	36,700

[W.-A., lot 1: Received July 19, 1895.]

Loaded September 28, 1895, with 41.8-grain charge, $E_{.36}$ primer and 0.12-inch metal case. Velocity when loaded, 1,973 feet. Stability, 26 to 30 minutes. Loss by heat test, 0.596 per cent.

[Exposed October 1, 1895. Test still in progress.]

Date of removal.	Time exposed.	Exposed.			Standard.			After heat test.			
								Exposed.		Standard.	
		Velocity.	Stability.	Loss, heat test.	Velocity.	Stability.	Loss, heat test.	Velocity.	Pressure.	Velocity.	Pressure.
1896.	Mos.			Per ct.			Per ct.				
Jan. 2...	3	1,831.6	56 to 60	2.114	1,946.8	59 to 60	0.695	....	....	....	....
Apr. 1...	6	1,946.8	73	1.416	1,954.4	73	.591	2,029.6	34.520	....	....
July 1...	9	1,965.2	42 to 60	1.056	1,972.8	No trace. a 109	.621	2,024.8	45,330	1,953.2	38,700

a This increase of stability by drying was very strongly shown in exposing a cannon powder, for 3.2-inch rifle, for some 350 hours to a temperature of 120° F., when it was raised from 36 to 85 minutes. The loss in weight was 3.105 per cent.

The velocity, though at first reduced, afterwards nearly regained that of the original powder.

In order to ascertain the effect on powder (in small-arms cartridges) when stored in a dry climate, 1,000 rounds of rifle cartridges, caliber .30, containing Peyton powder, lot 26, were sent, April 25, 1895, to Whipple Barracks, where they were to be stored in the original pasteboard boxes. The first lot (100 rounds) to be returned to Frankford Arsenal for examination six months after receipt, and others every three months thereafter.

On July 18, 1895, 1,000 rounds containing Leonard powder, lot 3, were forwarded to the same post to be treated in the same manner.

Duplicate cartridges were stored in the post magazine at Frankford Arsenal for comparison.

To determine pressures, cartridges were unloaded and the charges transferred to the pressure cases.

(See following tables.)

J. Pitman,
Major, Ordnance Department, U. S. A.

The Chief of Ordnance, U. S. Army,
Washington, D. C.
(Through the Commanding Officer, Frankford Arsenal.)

[Peyton, No. 26: Received February 5, 1895.]

Velocity when loaded, 1,982 feet. Loss by heat test, 1.059 per cent.

When received.	Whipple Barracks.				Frankford Arsenal.			
	Velocity.	Pressure.	Stability.	Loss, heat test.	Velocity.	Pressure.	Stability.	Loss, heat test.
1895.				*Per cent.*				*Per cent.*
Dec. 30..	1,999	36,000	41	1.212	1,960.8	33,500	39	1.302
1896.								
Mar. 27 .	1,981.8	35,500	31	1.037	1,962.8	35,350	32	1.107
June 19 .	2,007	38,600	36	1.087	1.984.4	39,340	36	1.146

[Leonard, No. 3: Received April 3, 1895.]

Velocity when loaded, 1,964 feet. Stability, 60 minutes. Loss by heat test, 0.240 per cent.

When received.	Whipple Barracks.				Frankford Arsenal.			
	Velocity.	Pressure.	Stability.	Loss, heat test.	Velocity.	Pressure.	Stability.	Loss, heat test.
1896.				*Per cent.*				*Per cent.*
Mar. 17..	1,928.1	30,500	43½	0.344	1,923.3	30,500	77	0.399
June 19 .	1,913.5	31,000	56 to 68	.403	1,914.2	30,600	56	0.432

Frankford Arsenal,
Philadelphia, Pa., September 22, 1896.

Respectfully forwarded to the Chief of Ordnance, United States Army.

J. P. Farley,
Lieutenant-Colonel, Ordnance Department, Commanding.

(10482)

APPENDIX 6.

TEST OF TWEEDIE (SOFT-NOSE) .30-CALIBER BULLET.

(1 plate.)

FRANKFORD ARSENAL,
Philadelphia, Pa., March 30, 1896.

SIR: In accordance with your instructions, I have the honor to submit the following report upon the soft-nosed (Tweedie patent) bullet referred to in O. O. file No. 13245.

Through the courtesy of the Union Metallic Cartridge Company, 100 bullets of the Tweedie design were furnished this arsenal. A test of them was made, with the following results:

Velocity.

	Feet per second.
Average of 10 shots	1,951.6
Mean variation	10.22
Extreme variation	44

Pressure.

		Pounds.
Average of 5 shots	per square inch..	39,979
Extreme pressure	do	43,150

Penetration at 10 feet.

In solid oak across grain.	In solid pine across grain.
Inches.	*Inches.*
4.0	12.0
4.5	13.0
3.0	12.5
	12.0
	11.0
Mean 3.83	Mean 12.1

Bullets recovered from penetration test forwarded herewith (Exhibit A) were fired into oak and (Exhibit B) into pine. Fired into timber at a distance of 3 feet, the service bullet penetrates solid oak 24 inches and solid pine 42 inches.

Two bullets were fired into sawdust at a distance of 45 feet. (Exhibit C.)

Two fired into sand and loam (mixed), at a distance of 45 feet, gave a penetration of 7 and 7½ inches. (Exhibit D.)

The service bullet at 500 yards penetrates sand and loam for a distance of 17 inches, and is but slightly deformed thereby.

Two fired through flesh (beef 5 inches in thickness) across grain and recovered in sawdust. Range simulated 500 yards. One jacket stripped in and tore a large hole through the flesh. Lead core doubled on itself. Point of second bullet flattened slightly; jacket did not strip. (Exhibit E.)

Two fired through flesh across grain (beef 5 inches in thickness). Range simulated 1,000 yards. Bullet recovered in sawdust. Point of bullet slightly flattened. Flesh torn but slightly. (Exhibit F.)

ACCURACY.

Four targets were fired for accuracy, with the following results:

	Feet.
Mean radius	1.64
Mean vertical deviation	1.086

Service bullets fired for comparison under similar conditions and at same time gave:

	Foot.
Mean radius	0.6
Mean vertical deviation	0.45

From the foregoing it will be seen that the bullet does not compare favorably with the service projectile, and the limited tests in flesh did not demonstrate that the bullet is satisfactory so far as mushrooming is concerned.[1]

Respectfully submitted.

LAWSON M. FULLER,
Lieutenant, Ordnance Department.

The COMMANDING OFFICER, FRANKFORD ARSENAL, PA.

Respectfully forwarded to the Chief of Ordnance, United States Army.

The mushroom bullet tested is shown by the within report to be inferior to the United States service bullets in particulars which more than offset advantages claimed for it. It should mushroom with certainty on striking a fleshy but not at the time vital portions of the human frame, and this it is not well calculated to do. If impact be on bone, the mushroom action follows and a wound in consequence should be the more serious, but not more so than one inflicted by the service bullet were it purposely contrived to strip its jacket.

Unfortunately the efforts to attain mushrooming effects with bullets are associated with features of construction well calculated to neutralize effectiveness against troops "taking cover."

Large game, against which the small caliber bullets in some instances have been said to be inoperative, may require to be dealt with by bullets with the mushroom property, but such animals do not "take cover," and hence the penetrating property of a bullet can be sacrificed for purposes of this kind.

J. P. FARLEY,
Lieutenant-Colonel, Ordnance Department, Commanding.

FRANKFORD ARSENAL, PA., *March 31, 1896.*

FRANKFORD ARSENAL,
Philadelphia, Pa., May 19, 1896.

SIR: In addition to my report on the Tweedie soft-nosed bullet, dated March 30, 1896, I have the honor to submit the following:

To determine whether this form of bullet was liable to strip its jacket and cause tumbling, ten targets were fired for accuracy at 500 yards and five at 660 yards (the extreme range obtainable). For comparison, five targets were fired with service bullets at each of the above ranges.

---

[1] In flesh.—J. P. F.

All firing was done with the heavy-accuracy barrel, cleaned after each target of ten shots:

Accuracy at 500 yards.				Accuracy at 660 yards.			
Service bullet.		Soft-nosed bullet.		Service bullet.		Soft-nosed bullet.	
Radius.	Mean vertical deviation.	Radius.	Mean vertical deviation.	Radius.	Mean vertical deviation.	Radius.	Mean vertical deviation.
Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0.44	0.235	0.72	0.630	0.61	0.395	1.34	0.820
0.56	0.455	0.68	0.555	0.51	0.350	1.19	0.995
0.57	0.495	0.65	0.470	0.54	0.325	1.60	1.160
0.67	0.600	0.68	0.530	0.67	0.575	1.57	1.205
0.46	0.200	0.84	0.685	0.68	0.360	0.98	0.805
		0.63	0.450				
		0.63	0.510				
		0.67	0.570				
		0.89	0.685				
		0.61	0.440				
Average 0.54	0.413	0.700	0.5525	0.602	0.401	1.336	0.997

From the above records, while there does not appear any tendency toward tumbling, it does appear that the accuracy falls off very rapidly for slight increase in the range. At 500 yards the accuracy is slightly better for the service bullet, but does not differ materially. At 660 yards, however, the mean radius and mean vertical deviation are more than doubled by using the soft-nosed projectile. It is even possible that were the range increased to 1,000 yards, the results would be so poor that using the soft-nosed bullet would be out of the question, due to its inaccuracy alone. In firing the soft-nosed bullet it was observed that at the greater range the center of impact was about 7 feet lower than with service bullet.

For its mushrooming effects in flesh three shots were fired with soft-nosed bullets into the flesh of a horse at each of the similated ranges of 100, 200, 300, and 400 yards.

At 100 yards the jacket was torn from one bullet and remained in the flesh. The lead core was not recovered. The other two bullets mushroomed well at this range and would have produced a very ugly wound. The jacket of one of these was not recovered. (Exhibit A.)

At 200 yards the mushrooming effect was very good also. Bullet jacket stripped in every case and was not recovered in one. (Exhibit B.)

At 300 yards the jackets did not strip and the mushrooming effect was very slight. (Exhibit C.)

At 400 yards the jackets did not strip and the bullet showed no tendency toward mushrooming. (Exhibit D.)

For effect on bone one bullet (service) was fired at each of the similated ranges of 100, 300, and 1,000 yards, and the test was repeated with soft-nosed bullets under similar conditions and at same ranges. (Fired into bone of horse's hind leg.)

At 100 yards the service bullet passed through the bone without deformation. At 300 and 1,000 yards the service bullet mushroomed and splintered the bone greatly. At all three ranges the soft-nosed bullet mushroomed and shattered the bone. (Exhibits E to J, inclusive.)

CONCLUSIONS.

To sum up, it appears:

First. That the accuracy of the soft-nosed bullet at 500 yards is inferior to that of the service projectile; at 660 yards it is very much inferior, and the conclusion seems natural that at extreme ranges the soft-nosed bullet can not be depended upon for even reasonably accurate results.

Second. Up to 300 yards the mushrooming effect of the soft-nosed bullet in flesh is very good, but beyond that range this bullet evidences no superiority over the service.

Third. In bone the soft-nosed bullet mushrooms at all ranges up to and including 1,000 yards; the service bullet seems to mushroom also beyond 100 yards, or from 300 up to 1,000, inclusive.

Respectfully submitted.

LAWSON M. FULLER,
Lieutenant, Ordnance Department.

The COMMANDING OFFICER, FRANKFORD ARSENAL, PA.

Approved and respectfully forwarded to the Chief of Ordnance, United States Army, in connection with letter No. 13245.

J. P. FARLEY,
Lieutenant-Colonel, Ordnance Department, Commanding.

FRANKFORD ARSENAL,
Philadelphia, Pa., June 3, 1896.

SIR: In accordance with your instructions I have the honor to submit the following description and drawing of the Tweedie soft-nosed bullet:

THE TWEEDIE SOFT-NOSED BULLET.

The mantle or jacket for this bullet is drawn up from cupro-nickel metal, 0.035 inch thick, as for the service bullet. In addition to the operations required for the service jacket, one other is required, viz, a flattening of the base or bottom of the jacket. After this operation the mantle is trimmed to required length and is ready for the core.

The slug or core is cast from pure lead swaged to proper size and shape. Being of pure lead, the weight of the completed bullet is thus increased from 220 to 223 grains.

The core is then inserted into the mantle from the front or point and the completed bullet swaged and sized. It is then cannelured on the same machine and in the same manner as is the service projectile.

Respectfully submitted.

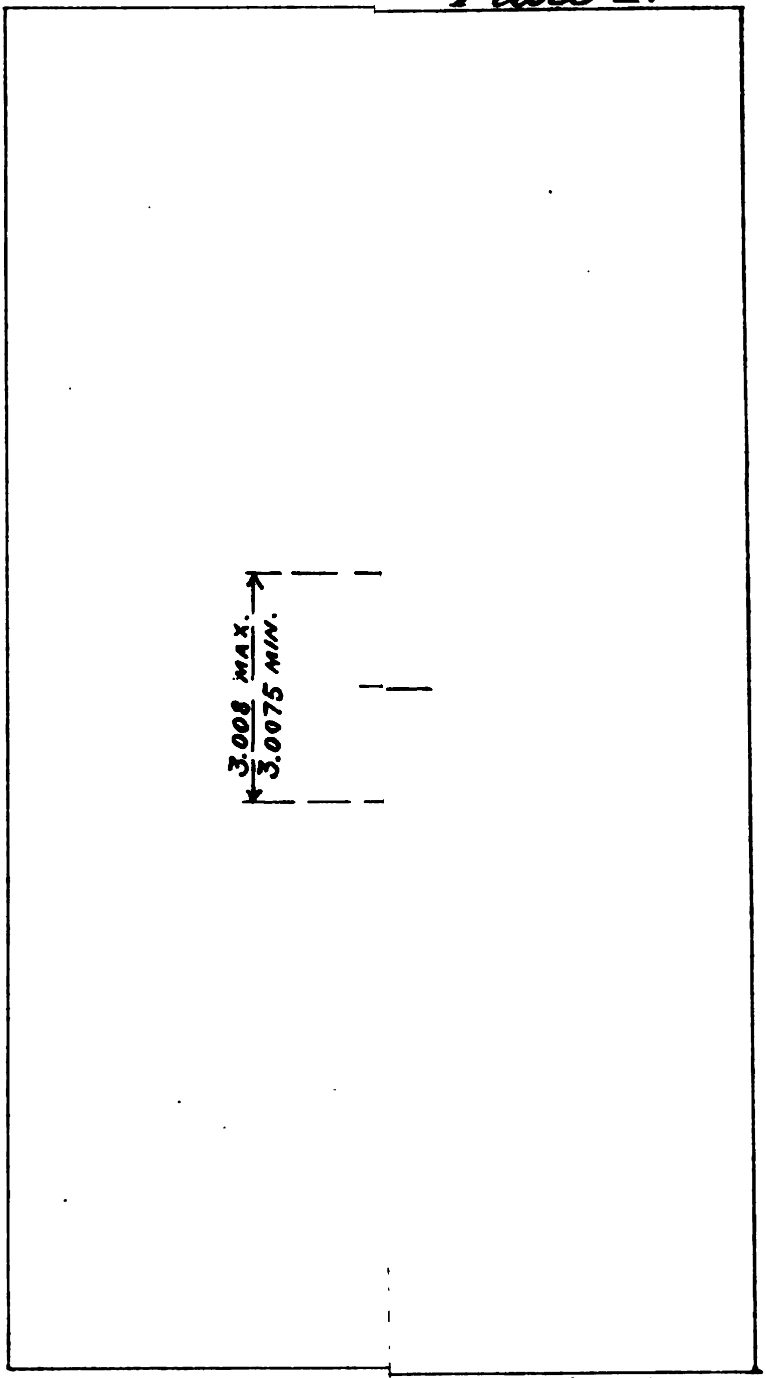
LAWSON M. FULLER,
Lieutenant, Ordnance Department.

The COMMANDING OFFICER, FRANKFORD ARSENAL, PA.

Approved and respectfully forwarded to the Chief of Ordnance, United States Army.

J. P. FARLEY,
(13245) *Lieutenant-Colonel, Ordnance Department, Commanding.*

Plate 1.



Appendix 6, 1896

Ord 54 2

APPENDIX 7.

DESCRIPTION OF FRANKFORD ARSENAL 3.2-INCH AND 3.6-INCH SHRAPNEL FOR BREECH-LOADING CANNON.

(4 plates.)

3.2-INCH 16.5-POUND SHRAPNEL.

[Drawing dated Frankford Arsenal, July, 1896; 15813—Enc. 6.]

The shrapnel, exclusive of filling, comprises the head, body, base, and band.

THE HEAD.

This is made of cast iron, machined on the exterior, and has a screw thread (18 threads per inch) cut around its base for attachment to forward end of body. It is bored and threaded to receive the Frankford Arsenal combination fuze. The head contains the powder chamber, which holds 3½ ounces of powder. Its interior surface is lacquered to prevent danger of premature ignition.

The head castings are furnished under the following specifications:

Shrapnel powder chambers, cored, best quality of iron and workmanship, smooth on inside and outside, free from gates and lumps. Sand must be well cleaned from inside and castings must be free from blow or sink holes. The interior must be concentric with exterior. Only 0.03-inch variation will be allowed on all measurements from the inside.

THE BODY.

This is made of lap-welded steel tubing containing not less than two-tenths of 1 per cent of carbon, or seamless drawn steel tubing containing from three-tenths to four-tenths of 1 per cent of carbon, machined on exterior and interior to dimensions and threaded front and rear (18 threads per inch) to receive the head and base. It is weakened for fracture by seven longitudinal grooves cut on the inside. These grooves are V-shaped, and their depth increases from nothing at rear to 0.08 inch at forward end of body, as shown by drawing.

To facilitate bursting and to prevent contact of rear part of body with rifling due to balloting while in bore, a finishing taper cut over rear part of body is made. The depth of this cut is nothing at a point 3.4 inches in front of band and increases uniformly to about 0.03 inch at a point 0.1 inch in front of band, where it ends.

The body contains the filling, which consists of 192 lead balls, 42+ to the pound, 0.5 inch in diameter, made from an alloy of 15 parts of lead to 1 of antimony, arranged in circular layers, and held in place by means of 40 cast-iron separators. The separators are segmental rings 0.49 inch in thickness, with hemispherical sockets in upper and lower surfaces to receive balls.

The separator castings are furnished under the following specifications:

Shrapnel separators, best quality iron castings, consisting of parts weighing from 1 to 4 ounces, smooth, sound, and free from sand-gate lumps; not to be enlarged by rapping or decreased by shrinkage, and when assembled in a mass of the required length should sustain a pressure of not less than 30,000 pounds without enlargement of diameter of mass. These separators must not be jumbled, and the separators must be true and squared.

In the following description of method of assembling filling, these separators are designated by the number of sockets they contain in each face.

The filling is assembled upside down, i. e., the top plate, which in completed shrapnel is in contact with bottom of powder chamber, is first placed on table flat side down. Balls are placed in all sockets, and the outside circular layer, containing 13 balls, is covered by four segmental separators, three 3^s and one 4. The inner circular layers in all cases are covered by two half-ring separators, care being taken to break joints always.

The operation is then continued as indicated in the following table:

1. Top plate.
2. Three 3^s, one 4, for outside layer; 2 half rings for inside layer.
3. Three 3^s, one 4, for outside layer; 2 half rings for inside layer. Break all joints.
4. Three 3^s, one 4, for outside layer; 2 half rings for inside layer. Break all joints.
5. Three 3^s, one 4, for outside layer; 2 half rings for inside layer. Break all joints.
6. Three 3^s, one 4, for outside layer; 2 half rings for inside layer. Break all joints.
7. Full rings for outside and inside layers.
8. Full rings for outside and inside layers.
9. Bottom plate.
10. Two half rings.
11. Two half rings. Break joints.

A supply of lead balls cast from an alloy containing equal parts of lead and antimony is kept on hand, and used when necessary to replace all or a part of the heavier balls in the three layers nearest base of shrapnel. By this means a slight reduction can be effected in adjusting total weight of shrapnel.

The separators prevent deformation and relative motion of balls under shock of discharge, and increase the effect of explosion by furnishing additional fragments.

The bottom plate has lugs which fit into recesses cast in the base and prevent relative rotation of the filling.

The full rings placed just above the bottom plate are 0.03 inch thicker than the segmental rings and are introduced to give increased strength to filling to resist shock of discharge.

The top plate, or separator, has a flat surface, against which the base of powder chamber is screwed.

THE BASE.

The base is of cast iron, threaded to screw into the rear of body. Recesses to receive lugs on bottom plate and hemispherical sockets for bottom layer of balls are cast in its upper surface.

The base castings are obtained under the following specifications:

Shrapnel bases, strong iron castings, sound and of best quality; must be smooth, free from gate lumps and sand.

The base supports the body under the rotating band.

The copper band, 0.5 inch wide and 0.25 inch thick, is cut from a seamless drawn copper tube. It is shrunk on its knurled seat with 0.02 shrinkage, and then, after screwing in base, it is passed through a die to force the copper into knurlings.

ASSEMBLING.

The base and body, the latter with band shrunk on, are first screwed together, the threads being covered with red lead.

The filling, previously packed and compressed by applying to it longitudinally a pressure of about 10,000 pounds, is then placed in body and the head screwed on.

The preliminary compression of filling is to solidify it, i. e., to produce contact of iron on iron throughout the mass, and should not result in binding the lead balls in their sockets, as this would prevent their free separation on explosion.

An essential feature of shrapnel requires that in screwing the head to its place close contact should be produced between base of head and top plate of filling, thereby causing the compressed filling to act as a solid mass under the shock of discharge. The pressure due to its inertia is borne entirely by the base, and no relative motion of parts of filling takes place.

To secure this contact of base of head and top plate it is generally necessary to place sheets of thin metal or paper between base of head and top plate of filling, the necessary number of sheets being determined by trial in each case.

The total number of balls and individual pieces in a shrapnel complete is 236.

Table of maximum and minimum weights and dimensions of the Frankford Arsenal 16.5-pound shrapnel for 3.2-inch breech-loading rifle.

Weights and dimensions.		Maximum.	Minimum.
Weight without fuze or bursting charge	pounds	15	15
	ounces	6	3
Total length (without fuse)	inches	9.12	9.10
Length of head (without fuse)	do	2.80	
Inside diameter of body	do	2.77	
Outside diameter of body, over base of head	do	3.172	3.168
Outside diameter of base (at band) (*a*)	do	3.182	3.178
Diameter of head at front	do	1.96	
Radius of head, outside	do	5.5	
Radius of head, inside	do	3	
Thickness of base	do	2.25	
Thickness of separators	do	0.49	
Thickness of top plate	do	0.25	
Thickness of bottom plate	do	0.25 0.40	
Thickness of full rings	do	0.52	
Thickness of walls of powder chamber	do	0.375	
Length of body	do	5.823	
Depth of fuse seat to end of thread	do	1	
Diameter of fuse seat without threads	do	1.18	
Threads per inch		8	
Exterior diameter of band	inches	3.310	3.307
Width of band	do	0.505	0.495
Distance of band from base	do	1.75	
Diameter of ball	do	0.5	
Weight of ball (42 to the pound)	grains	166	
Number of balls		192	
Number of separators		40	
Total number of pieces		236	
Weight of fuse	pounds	1	
	ounces	1	
Weight of powder charge	ounces	3.5	
Total weight of shrapnel	pounds	16	16
	ounces	10.5	7

a Base tapered 0.003 inch from band to rear.

3.6-INCH 20-POUND SHRAPNEL.

[Drawing dated Frankford Arsenal, July, 1896; 15813—Enc. 7.]

The foregoing detailed description of the 3.2-inch shrapnel applies also to the 3.6-inch shrapnel except as regards the details of the filling of balls and separators and the dimensions, etc., of parts as shown on drawings and stated in the following schedule for filling and table of weights and dimensions.

The filling of lead balls and cast-iron separators is assembled according to the following schedule:

1. Top plate.
2. Five 2^s, one 3, for outside layer; 2 half rings for inside layer. Break all joints.
3. Five 2^s, one 3, for outside layer; 2 half rings for inside layer. Break all joints.
4. Five 2^s, one 3, for outside layer; 2 half rings for inside layer. Break all joints.
5. Full plate separator.
6. Five 2^s, one 3, for outside layer; 2 half rings for inside layer.
7. Five 2^s, one 3, for outside layer; 2 half rings for inside layer. Break all joints.
8. Three 3^s, one 4, for outside layer; 2 half rings for inside layer. Break all joints.
9. Full ring separators for outside and inside layers.
10. Full ring separators for outside and inside layers.
11. Bottom plate.

Table of maximum and minimum weights and dimensions for the Frankford Arsenal 3.6-inch shrapnel.

Weights and dimensions.	Maximum.	Minimum.
Weight without fuse or bursting charge .... pounds..	18	18
ounces..	14	9
Total length (without fuse) .... inches..	9.30	9.28
Length of head (without fuse) ....do....	3.12	....
Inside diameter of body ....do....	3.15	....
Outside diameter of body ....do....	3.572	3.568
Outside diameter of base (below band) ....do....	3.582	3.578
Diameter of head at front ....do....	1.96	....
Radius of head, outside ....do....	5.4	....
Radius of head, inside ....do....	3.5	....
Thickness of base ....do....	1.25	....
Thickness of separators ....do....	0.484	....
Thickness of top plate ....do....	0.25	....
Thickness of bottom plate ....do....	0.25 0.484	....
Thickness of full rings ....do....	0.505	....
Thickness of walls of powder chamber ....do....	0.4	....
Thickness of walls of body ....do....	0.211	0.209
Length of body ....do....	6.74	....
Depth of fuse seat to end of thread ....do....	1.12	....
Diameter of fuse seat within threads ....do....	1.18	....
Threads per inch	8	....
Exterior diameter of band .... inches..	3.700	3.696
Width of band ....do....	0.505	0.495
Distance of band from base ....do....	0.75	....
Diameter of ball ....do....	0.5	....
Weight of ball (42 to the pound) .... grains..	166	....
Number of balls	218	....
Number of separators	54	....
Total number of pieces	276	....
Weight of fuse .... pounds..	1	....
ounces..	1	....
Weight of powder charge .... ounces..	4	....
Total weight of shrapnel (*a*) .... pounds..	20	19
ounces..	2	13

a This weight applies to the shrapnel with 15-seconds fuse for 3.6-inch B. L. rifle. The 28-seconds fuse used with this shrapnel for the 3.6-inch B. L. mortar increases the total weight 2.5 ounces.

DESCRIPTION OF PACKING BOXES FOR 3.2 AND 3.6 INCH SHRAPNEL.

These boxes are made of dressed white-pine boards, the side and end pieces being connected by dovetail joints and nails and the top and bottom pieces being held in place by screws.

The box for 3.2-inch holds eight and that for 3.6-inch six shrapnel.

Each box has fixed to its bottom on the inside a lattice frame with recesses to receive the bases of shrapnel.

After packing shrapnel, a detachable lattice frame, constructed as shown in drawing, is placed on top of them, inside the box, to hold them rigidly in place.

This frame rests on the ogives of projectiles and is pressed firmly against them when top of box is screwed on. The recesses in this frame are reamed on the underside to fit ogives. The reaming is done on boring machine by a specially constructed tool.

The dimensions of the parts of these boxes are given in the following tables, and the method of assembling them is shown by the accompanying drawings:

Table showing dimensions of parts of packing box for 3.2-inch 16.5-pound shrapnel.

Parts.	Number of pieces.	Dimensions.
Box:		*Inches.*
Bottom	1	7/8 by 10 3/8 by 18 3/4
Top	1	7/8 by 10 3/8 by 18 3/4
Ends	2	7/8 by 10 3/8 by 13
Sides	2	7/8 by 13 by 18 3/4
Bottom lattice frame:		
Longitudinal pieces	3	3/4 by 1/2 by 16 1/2
Crosspieces	5	3/4 by 1/2 by 8 5/8
Top lattice frame:		
Longitudinal ribs	2	5/8 by 2 3/4 by 16 1/2
Cross ribs	2 1	5/8 by 2 3/4 by 8 5/8 7/8 by 2 3/4 by 8 5/8
Longitudinal pieces	2 1	7/8 by 1 3/4 by 16 1/2 7/8 by 1 3/4 by 16 1/2
Crosspieces	2 3	7/8 by 1 3/4 by 8 5/8 5/8 by 1 5/8 by 8 5/8
Handle pieces	2	1 1/8 by 1 3/4 by 10
Rope handles	2	About 25 inches long, 3/4-inch rope.

Table showing dimensions of parts of packing box for 3.6-inch shrapnel.

Parts.	Number of pieces.	Dimensions.
Box:		*Inches.*
Bottom	1	7/8 by 11 1/8 by 15 5/8
Top	1	7/8 by 11 1/8 by 15 5/8
Sides	2	7/8 by 11 1/16 by 15 5/8
Ends	2	7/8 by 11 1/8 by 11 11/16
Bottom lattice frame:		
Longitudinal pieces	3	11/16 by 11/16 by 13 7/8
Crosspieces	4	11/16 by 3/4 by 9 3/8
Top lattice frame:		
Longitudinal ribs	2	3/4 by 2 3/8 by 13 7/8
Cross ribs	4	11/16 by 2 3/8 by 9 3/8
Longitudinal pieces	2 1	7/8 by 1 7/16 by 13 7/8 7/8 by 2 by 13 7/8
Crosspieces	2 2	7/8 by 1 7/16 by 9 3/8 7/8 by 2 1/4 by 9 3/8
Handle pieces	2	1 1/8 by 1 3/4 by 11
Rope handles	2	About 25 inches long, 3/4-inch rope.

Plate 1.

3,2 INCH SHRAPNEL
FOR FIXED AMMUNITION
MODEL Nº 1

FIG. 1

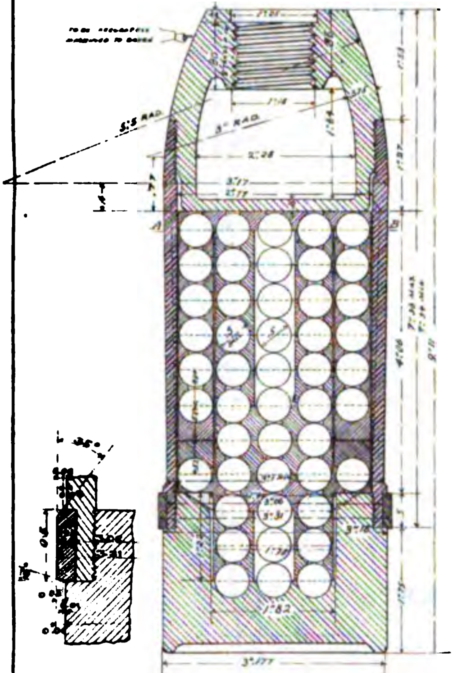


FIG. 2

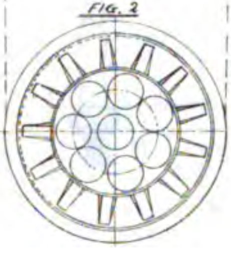
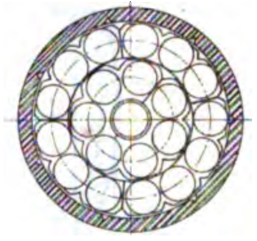


FIG. 3
SECTION ON AB



TOP SEPARATOR

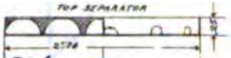
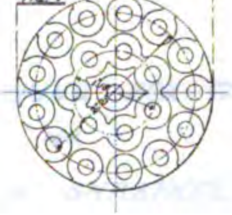


FIG. 4



BOTTOM SEPARATOR

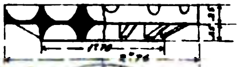
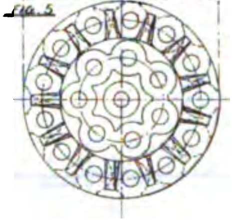


FIG. 5



FULL RING SEPARATOR

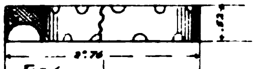
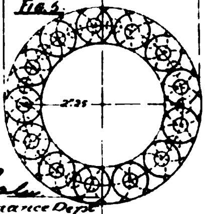


FIG. 6



Nº OF BALLS 192
" " SEPARATORS 40
CASE, POWDER CUP, BASE, BAND 4
TOTAL Nº OF PIECES . . . 236

WEIGHT OF POWDER . . . OUNCE . . 3.5

TOTAL WEIGHT OF SHRAPNEL { MAX. . LBS. 16 $\frac{13}{16}$
{ MIN. " " 16 $\frac{8}{16}$

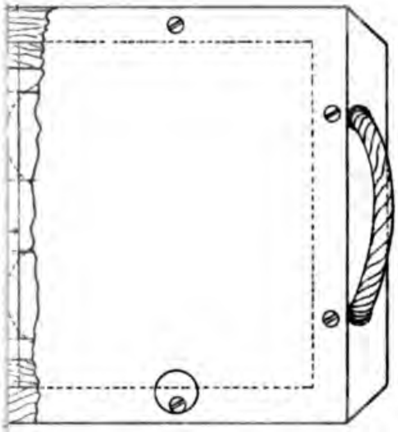
Frankford Arsenal July 1896

Approved:
Charles Shaler
Captain Ordnance Dept
Acting Chief of Ordnance.

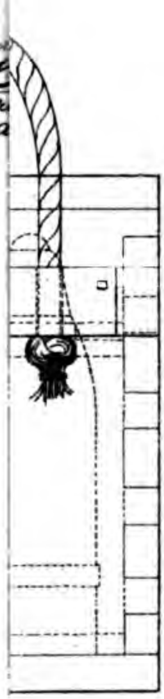
Appendix 7. 1896

Ord 54 2

Plate II.



Approved



PACKING BOX. DRESSED LUMBER.

FOR

3.2 INCH SHRAPNEL.

Frankford Arsenal

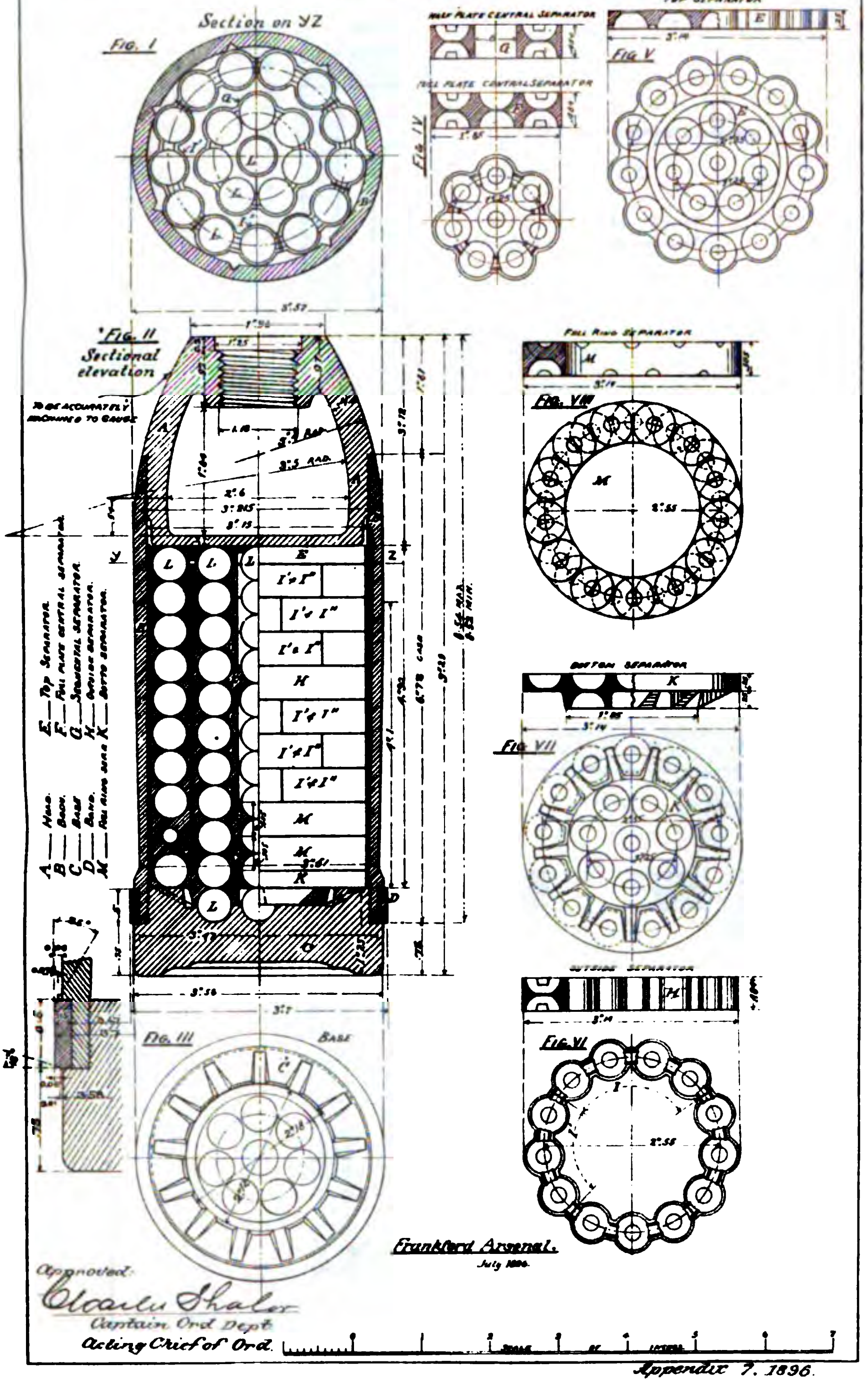
July 1896

Appendix 7, 1896.

Ord 54 2

THE FRANKFORD ARSENAL SHRAPNEL FOR 3.6 INCH B.L. RIFLE.

Model 1896.



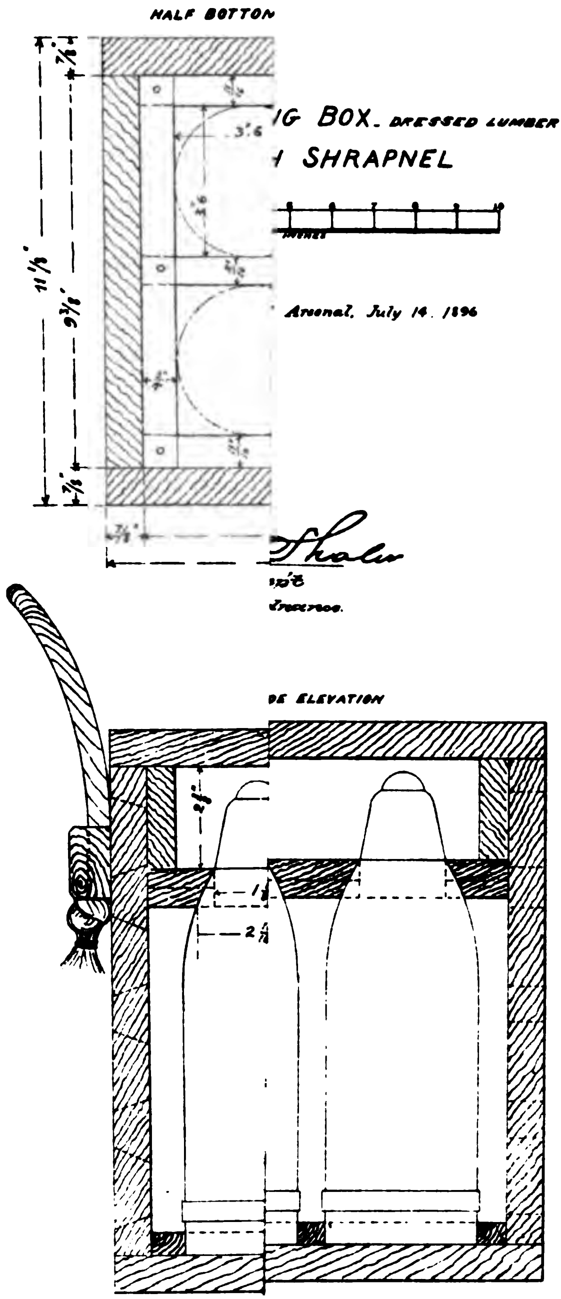
Frankford Arsenal.
July 1896.

Approved:
Charles Shaler
Captain Ord Dept.
Acting Chief of Ord.

Appendix 7. 1896.

Ord 54 2

Plate IV.



G BOX. DRESSED LUMBER.

SHRAPNEL

INCHES

Arsenal, July 14. 1896

Shaler

Appendix 7, 1896

Ord 54 2

APPENDIX 8.

DESCRIPTION OF FRANKFORD ARSENAL 5-INCH SHRAPNEL, MODEL 1896.

(7 plates.)

The shrapnel, Pl. I, consists of the following parts, viz: Head, case, base, band, central tube, balls, and separators.

HEAD.

The head is of cast iron, machined on the exterior, and has a screw thread (18 threads per inch) cut around its base for attachment to forward end of case. It is bored and threaded to receive the Frankford Arsenal combination fuze. The central tube is screwed into base of head, and this, together with cavity in head, furnishes space for the bursting charge, which consists of 12 ounces of powder.

The holes in casting for fuze and central tube make it an easy matter to center the case and hold it in place.

The powder chamber is lacquered to prevent danger of premature ignition.

CASE.

The case is made from lap-welded steel tubing containing not less than two-tenths of 1 per cent of carbon, or from seamless drawn-steel tubing containing from three-tenths to four-tenths of 1 per cent of carbon.

It is machined to dimensions on exterior and interior and is threaded front and rear (18 threads per inch) for attachment to head and base. It is weakened for fracture by 11 longitudinal grooves cut on the inside. These grooves are V-shaped and their depth increases from nothing at rear to 0.12 inch at forward end of case.

To facilitate bursting and to prevent contact of rear part of case with lands a finishing taper cut over exterior of case is made. The length of this taper cut is 4.6 inches and its maximum depth, just in front of rotating band, is 0.065 of an inch.

The case contains the filling, which consists of 280 round lead balls, 42 to the pound, 0.5 inch in diameter, cast from an alloy of 15 parts of lead to 1 of antimony, arranged in circular layers and held in place by 59 cast-iron separators. The separators are segmental rings with hemispherical sockets in upper and lower surfaces to receive balls.

A supply of lead balls cast from an alloy containing equal parts of lead and antimony is kept on hand and used, when necessary, to replace all or a part of the heavier balls in the three layers nearest base of shrapnel. By this substitution a slight reduction can be effected in adjusting total weight of shrapnel.

Record of firing with 5-inch B. L. rifle (steel), model 1890,

[Object of firing, test of

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Pressure per square inch of bore.	Wind, strength, and direction.
		Kind.	Weight.	Kind.	Weight.			
			Lbs. Oz.		*Lbs. Oz.*	° ′	*Pounds.*	
July 20	11	Du Pont's sphero-hexagonal, sample 2, 1896.	9 10½	Frankford Arsenal shrapnel, lot 741, without central tube.	45 1½ 14 powder bursting charge.	1 8	40, 26, 120	Wind from right and rear, 30°, 16 miles an hour; barometer, 30.18; thermometer, 82°; humidity, 76.
July 21	12		9 10½	Frankford Arsenal shrapnel, lot 742, with central tube.	44 11½ 12 powder bursting charge.	55	40, 25, 500	Wind from right and rear, 30°, 12 miles an hour; barometer, 30.18; thermometer, 82°; humidity, 76.

No. 11, at Sandy Hook Proving Ground, July 20 and 21, 1896.

Frankford Arsenal shrapnel.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
The shrapnel struck the screen 1 foot from the top and 4 feet 6 inches from the left edge, and burst after passing through. The number of hits on target as follows: Bullets through .... 303 Bullets imbedded .... 2 Bullets made mark .... 4 Fragments through .... 87 Fragments imbedded .... 4 Fragments made mark .... 9 Total .... 409 87 per cent of the hits on the portion of the target 2 inches thick through. 75 per cent on the 3 inches through .... 64 per cent on the 4 inches through .... 71 per cent on the 5 inches through .... 6 per cent on the 6 inches through .... 12 per cent on the 7 inches through .... Number of pieces as per drawing: Number of balls .... 348 Number of separators .... 73 Case, powder chamber, base, band .... 4 Total .... 425 The shrapnel struck the screen 3 feet 7 inches from the top and 3 feet 3 inches from the left edge, and burst on passing through. The number of fragments on target as follows: Bullets through .... 225 Bullets imbedded .... 0 Bullets made mark .... 0 Fragments through .... 304 Fragments imbedded .... 27 Fragments made mark .... 9 Total .... 565 43 per cent of the hits on the portion of the target 2 inches thick through. 25 per cent on the 3 inches through .... 67 per cent on the 4 inches through .... 0 per cent on the 5 inches through .... 0 per cent on the 6 inches through .... 0 per cent on the 7 inches through .... The first shot having struck a little high, owing to jump on carriage, the elevation for the second was reduced to 55 minutes.	Gun mounted on free recoil carriage. Gun fired at target 39 feet wide by 30 feet high by 1 inch thick, placed 194 yards in front of the muzzle. Percussion fuses were used to burst the shrapnel on passing through a screen placed 90 feet in front of the target. This screen was 6 feet high by 8 feet wide and 2 inches thick, and placed with its center about 13½ feet above the ground. The gun was given an elevation (calculated) such that the shrapnel would have pierced the center of the target had it not burst on passing through the screen. The charge was calculated to give a velocity (1,497 feet per second) at the target equal to the remaining velocity at 1,000 yards using a full charge. To determine the penetration of the bullets and fragments the center of the target was increased in thickness as follows: A horizontal layer 6½ feet on each side of the center of the target and 9 inches wide was increased to 7 inches in thickness. Directly above was a corresponding layer 4 inches in thickness, and above this a layer 2 inches in thickness. Directly below the 7 inch layer was one 5 inches thick, and below this another 3 inches in thickness.

Record of firing with 5-inch B. L. rifle (steel), model 1890,

[Object of firing, test of

Date.	No. of fire.	Powder.		Projectile.		Elevation.		Pressure per square inch of bore.	Wind, strength, and direction.
		Kind.	Weight.	Kind.	Weight.				
			Lbs. *Oz.*		*Lbs.* *Oz.*	°	′	*Pounds.*	
July 20	11	Du Pont's sphero-hexagonal, sample 2, 1896.	9 10½	Frankford Arsenal shrapnel, lot 741, without central tube.	45 1½ 14 powder bursting charge.	1	8	40, 26, 120	Wind from right and rear, 30°, 16 miles an hour; barometer, 30.18; thermometer, 82°; humidity, 76.
July 21	12		9 10½	Frankford Arsenal shrapnel, lot 742, with central tube.	44 11½ 12 powder bursting charge.		55	40, 25, 500	Wind from right and rear, 30°, 12 miles an hour; barometer, 30.18; thermometer, 82°; humidity, 76.

No. 11, at Sandy Hook Proving Ground, July 20 and 21, 1896.

Frankford Arsenal shrapnel.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
The shrapnel struck the screen 1 foot from the top and 4 feet 6 inches from the left edge, and burst after passing through. The number of hits on target as follows: Bullets through .... 303 Bullets imbedded .... 2 Bullets made mark .... 4 Fragments through .... 87 Fragments imbedded .... 4 Fragments made mark .... 9 Total .... 409 87 per cent of the hits on the portion of the target 2 inches thick through. 75 per cent on the 3 inches through. 64 per cent on the 4 inches through. 71 per cent on the 5 inches through. 6 per cent on the 6 inches through. 12 per cent on the 7 inches through. Number of pieces as per drawing: Number of balls .... 348 Number of separators .... 73 Case, powder chamber, base, band .... 4 Total .... 425 The shrapnel struck the screen 3 feet 7 inches from the top and 3 feet 3 inches from the left edge, and burst on passing through. The number of fragments on target as follows: Bullets through .... 225 Bullets imbedded .... 0 Bullets made mark .... 0 Fragments through .... 304 Fragments imbedded .... 27 Fragments made mark .... 9 Total .... 565 43 per cent of the hits on the portion of the target 2 inches thick through. 25 per cent on the 3 inches through. 67 per cent on the 4 inches through. 0 per cent on the 5 inches through. 0 per cent on the 6 inches through. 0 per cent on the 7 inches through. The first shot having struck a little high, owing to jump on carriage, the elevation for the second was reduced to 55 minutes.	Gun mounted on free recoil carriage. Gun fired at target 39 feet wide by 30 feet high by 1 inch thick, placed 194 yards in front of the muzzle. Percussion fuses were used to burst the shrapnel on passing through a screen placed 90 feet in front of the target. This screen was 6 feet high by 8 feet wide and 2 inches thick, and placed with its center about 13½ feet above the ground. The gun was given an elevation (calculated) such that the shrapnel would have pierced the center of the target had it not burst on passing through the screen. The charge was calculated to give a velocity (1,497 feet per second) at the target equal to the remaining velocity at 1,000 yards using a full charge. To determine the penetration of the bullets and fragments the center of the target was increased in thickness as follows: A horizontal layer 6½ feet on each side of the center of the target and 9 inches wide was increased to 7 inches in thickness. Directly above was a corresponding layer 4 inches in thickness, and above this a layer 2 inches in thickness. Directly below the 7 inch layer was one 5 inches thick, and below this another 3 inches in thickness.

Record of firing with 5-inch B. L. rifle (steel), model 1890,

Date.	No. of fire.	Powder.		Projectile.		Depression.	Pressure per square inch of bore.	Wind, strength, and direction.
		Kind.	Weight.	Kind.	Weight.			
			Lbs. *Oz.*		*Lbs.* *Oz.*		*Pounds.*	
July 24	11	Du Pont's sphero-hexagonal, I. B. E.	13 0	Frankford Arsenal shrapnel, lot 741, without central tube.	50 15½	42	30, 36,780	Wind from front and right, 20 miles an hour; barometer, 29.96; thermometer, 68°; humidity, 95.
July 24	12		13 0	Frankford Arsenal shrapnel, lot 742, central tube.	50 4½	45	40, 37,000	

Record of firing with 5-inch B. L. siege rifle (steel), model 1890, No. 11,

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Pressure per square inch of bore.	Recoil.	Wind, strength, and direction.
		Kind.	Weight.	Kind.	Weight.				
			Lbs. *Oz.*		*Lbs.* *Oz.*	° ′	*Pounds.*	*Feet.*	
July 30	13	Du Pont's sphero-hexagonal, sample 2, 1896.	9 10½	Frankford Arsenal shrapnel, central tube.	44 12 12 powder.	1 8	40, 26,320	14	Wind from right and rear, 40°, 11 miles an hour; barometer, 30; thermometer, 86°; humidity, 67.

No. 3, at Sandy Hook Proving Ground, July 24, 1896.

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Number of pieces as per drawing: Number of balls ..... 280 Number of separators ..... 62 Case, powder chamber, base ring, and tube ..... 5 Total ..... 347 The shrapnel passed through the 4-inch screen and broke up in sand butt. Head, body, and base broken into several pieces; marks of rifling on fragments near the bourrelet.	Gun mounted on steel siege carriage. This gun has been returned from Watervliet Arsenal after having a new trunnion hoop to replace the one broken. Since last firing the carriage has been sent to Rock Island Arsenal, and the following repairs have been made: A new loading step put below the first on the trail; and a strengthening piece riveted on both sides of trail. Fired into sand butt.
The shrapnel passed through the 4-inch screen, making a clean hole. When recovered the base was broken off and the head started from the body, a bulge on body in front of band, and marks of rifling on body in rear of bourrelet.	

at Sandy Hook Proving Ground, July 30 and 31, 1896.

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
The shrapnel struck the screen 6 feet 6 inches from the top and 3 feet 9 inches from the left edge, and burst after passing through. The number of hits on target as follows: Bullets through ..... 169 Bullets imbedded ..... 0 Bullets made mark ..... 0 Fragments through ..... 139 Fragments imbedded ..... 38 Fragments made mark ..... 32 Total ..... 378 Number of pieces as per drawing, same as round 12. 100 per cent of the hits on the portion of the target 2 inches thick, through hits. 100 per cent of the hits on the portion of the target 3 inches thick, through hits. 0 per cent of the hits on the portion of the target 4 inches thick, through hits. 0 per cent of the hits on the portion of the target 5 inches thick, through hits. 100 per cent of the hits on the portion of the target 6 inches thick, through hits. 0 per cent of the hits on the portion of the target 7 inches thick, through hits.	Gun mounted on free recoil carriage. The screen was placed 150 feet in front of the target. This screen was 9 feet 6 inches high by 8 feet wide by 2 inches thick, and placed with its center 12¾ feet above the ground.

Record of firing with 5-inch B. L. siege rifle (steel), model 1890, No. 11, at Sandy

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Pressure per square inch of bore.	Recoil.	Wind, strength, and direction.
		Kind.	Weight.	Kind.	Weight.				
			Lbs. *Oz.*		*Lbs.* *Oz.*	° '	*Pounds.*	*Feet.*	
July 31	14	Du Pont's sphero-hexagonal, sample 2, 1896.	9 10½	Frankford Arsenal shrapnel, without central tube.	45 2 14 powder.	1 8	40, 27,060	14	Wind from front and left, 30°, 24 miles an hour; barometer, 30; thermometer, 76°; humidity, 87.

Record of firing with 5-inch B. L. rifle (steel), model 1890,

Date.	No. of fire.	Powder.		Projectile.		Depression.	Pressure per square inch of bore.	Wind, strength, and direction.
		Kind.	Weight.	Kind.	Weight.			
			Lbs. *Oz.*		*Lbs.* *Oz.*	'	*Pounds.*	
July 31	13	Du Pont's sphero-hexagonal, I. B. E.	12 12	Frankford Arsenal shrapnel, without central tube.	46 1	46	40, 37,067	Wind from front and left, 30°, 20 miles an hour; barometer, 30 13; thermometer, 81°; humidity, 67.
July 31	14		12 12	Frankford Arsenal shrapnel, with central tube.	45 4	° 1	40, 36,578	

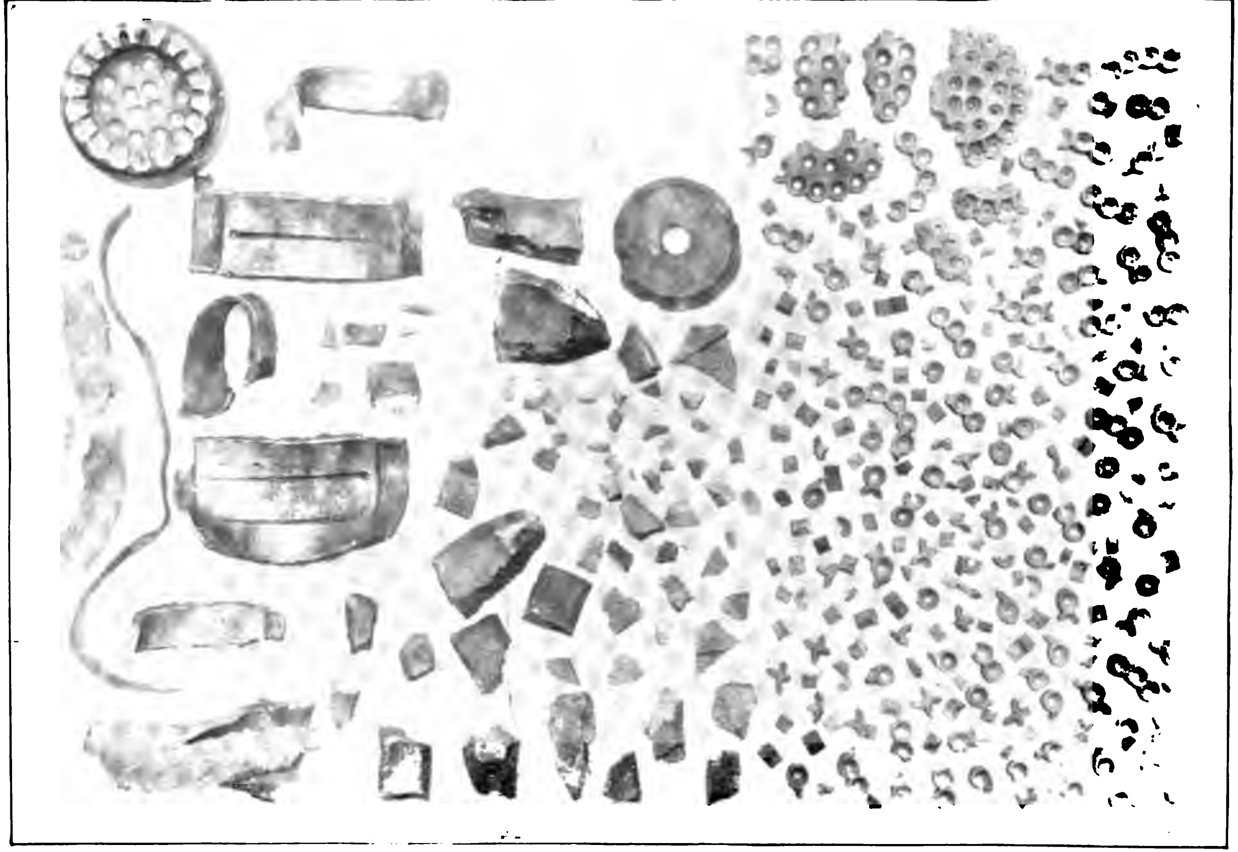
Hook Proving Ground, July 30 and 31, 1896—Continued.

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
The shrapnel struck the screen 7 feet 9 inches from the top and 5 feet 6 inches from the left edge, and burst after passing through. The number of hits on the target as follows: Bullets through .... 276 Bullets imbedded .... 0 Bullets made mark .... 0 Fragments through .... 89 Fragments imbedded .... 0 Fragments made mark .... 8 Total .... 373 The number of hits as per drawing, same as round 11. 83 per cent of the hits on the portion of target 2 inches thick, through hits. 47 per cent of the hits on the portion of target 3 inches thick, through hits. 67 per cent of the hits on the portion of target 4 inches thick, through hits. 44½ per cent of the hits on the portion of target 5 inches thick, through hits. 50 per cent of the hits on the portion of target 6 inches thick, through hits. 33⅓ per cent of the hits on the portion of target 7 inches thick, through hits.	The elevation was increased slightly over the elevation used with the bursting screen 90 feet from the target. This was done because of the loss of velocity of the fragments of the explosion and of the increased distance of the burst from the target.

No. 3, at Sandy Hook Proving Ground, July 31, 1896.

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
The shrapnel passed through the 4-inch screen and broke up in sand butt; head, body, and base broken into small fragments, no marks of rifling on fragments.	Gun mounted on 5-inch siege carriage. Fired into 6-pounder sand butt through a 4-inch screen placed about 6 feet in front of butt. Firing conducted by Lieut. C. L'H. Ruggles, Ordnance Department. Frank Heath, Captain, Ordnance Department, U. S. A., Commanding.
The shrapnel passed through the 4-inch screen and into sand butt; recovered whole, slight bulge in front of band, also slight marks of rifling on bulge.	

PLATE II.



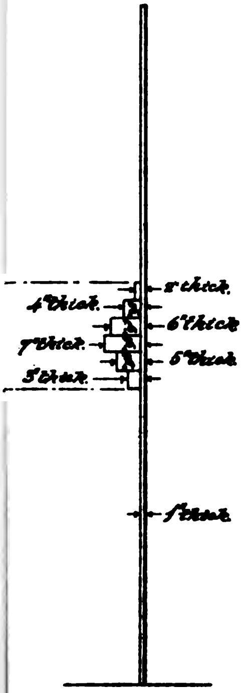
WITH CENTRAL TUBE.

Appendix 8, 1896.

Plate IV.

'. J. July 21st 1896. Round. No 12.

44794 - Vel. at 1000 yds using full charge.



LEGEND.

BULLETS THROUGH,	223
" EMBEDDED,	0
" MADE MARK,	0
FRAGMENTS THROUGH,	304
" EMBEDDED,	27
" MADE MARK,	9
TOTAL	563

he portion of target 2" thick were through hits.
" " " " 3" " " " "
" " " " 4" " " " "
" " " " 5" " " " "
" " " " 6" " " " "
" " " " 7" " " " "

Ground, July 31st 1896.

Appendix 8, 1896.

Ord 54 2

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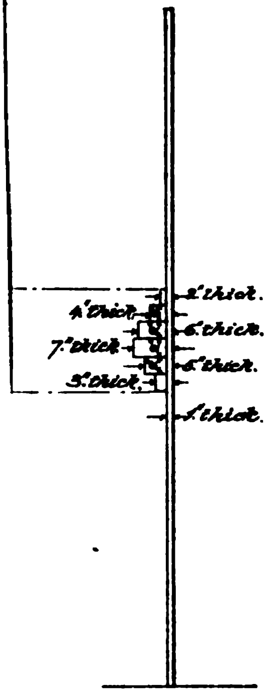
Sandy Hook, N.J. July 30th 1896. Round No 13.

elocity at 194 yds. = 1479 f = Vel. at 1000 yds. using full charge.



Legend.

Bullets through, 169.
" embedded, 0.
" made mark, 0.
Fragments through, 139.
" embedded, 38.
" made mark, 32.
total 378.

the portion of target 2" thick were through hits.
" " " " 3" " " " "
" " " " 4" " " " "
" " " " 5" " " " "
" " " " 6" " " " "
" " " " 7" " " " "

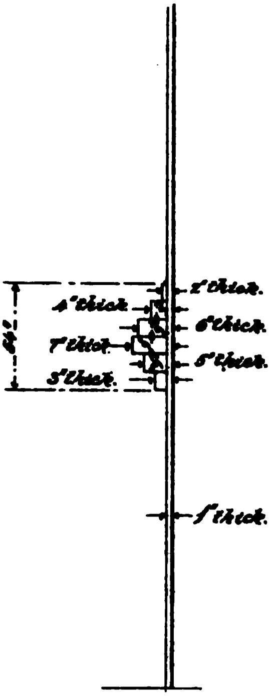
oving Ground. July 31st 1896.

Appendix 8, 1896.

ty H
4 yds

dy Hook, N. J. July 20th 1896. Round No. 11.

4 yds. =44.79% = Vel. at 1000 yds. using full charge.



LEGEND.

X BULLETS THROUGH, 308
⊗ " EMBEDDED, 2
○ " MADE MARK, 4
△ FRAGMENTS THROUGH, 87
△ " EMBEDDED, 4
△ " MADE MARK, 2
TOTAL [illegible]

n the portion of target 2" thick were through hits.

" " " " " 3" " " " "
" " " " " 4" " " " "
" " " " " 5" " " " "
" " " " " 6" " " " "
" " " " " 7" " " " "

und, July 31st 1896.

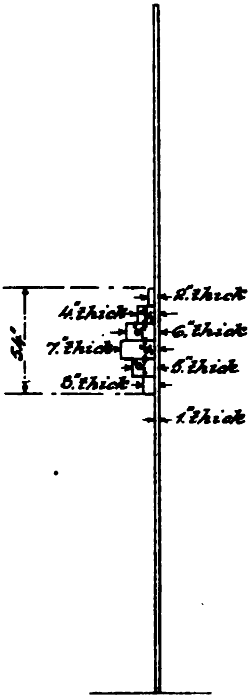
Appendix 8, 1896.

Ord 54 2

Plate VII.

'at Sandy Hook, N. J. July 31st 1896 Round No 14

ity at 194 yds.-1479 f/s - Vel. at 1000 yds using full charge.



Legend:

X	Bullets through	276.
⊗	" embedded	0.
○	" made mark	0.
△	Fragments through	89.
	" embedded	0.
	" made mark	8.
	total	373.

on the portion of target 2" thick were through hits
" " " " " 3" " " " "
" " " " " 4" " " " "
" " " " " 5" " " " "
" " " " " 6" " " " "
" " " " " 7" " " " "

roving Ground, July 31st 1896.

Ord 54 2

APPENDIX 9.

DESCRIPTION OF FRANKFORD ARSENAL 7-INCH SHRAPNEL, MODEL 1896.

(7 plates.)

The shrapnel consists of the following parts, viz: Head, case, base, band, central tube, balls, and separators.

HEAD.

The head is of cast iron, machined on the exterior, and has a screw thread (16 threads per inch) cut around its base for attachment to forward end of case. It is bored and threaded to receive the Frankford Arsenal combination fuse. The central tube is screwed into base of head, and this, together with cavity in head, furnishes space for the bursting charge, which consists of 30 ounces of powder.

The holes in casting for fuse and central tube make it an easy matter to center the case and hold it in place.

The powder chamber is lacquered to prevent danger of premature ignition.

CASE.

The case is made from lap-welded steel tubing containing not less than two-tenths of 1 per cent of carbon, or from seamless drawn steel tubing containing from three-tenths to four-tenths of 1 per cent of carbon.

It is machined to dimensions on exterior and interior and is threaded front and rear, 16 threads per inch, for attachment to head and base. It is weakened for fracture by 16 longitudinal grooves cut on the inside. These grooves are V-shaped, and their depth increases from nothing at rear to 0.14 inch at forward end of case.

To facilitate bursting and to prevent contact of rear part of case with lands, a finishing taper cut over exterior of case is made. The length of this taper cut is 7.17 inches, and its maximum depth, just in front of rotating band, is 0.08 inch.

The case contains the filling, which consists of 449 lead balls, 0.665 inch in diameter, weighing about 1 ounce each, and 95 cast-iron separators. The separators are segmental rings 0.664 inch in thickness, with hemispherical sockets in upper and lower surfaces to receive balls.

The separators prevent deformation and relative motion of balls under shock of discharge, and increase the effect of explosion by furnishing additional fragments.

The bottom separator (N) has lugs (Fig. VI), which fit in recesses cast in the base, and prevent relative rotation of interior filling.

The top separator (E, Fig. III) has a flat surface, on which base of head rests when shrapnel is assembled.

BASE.

The base is of cast iron, machined on exterior and threaded for attachment to rear of case. Recesses to receive lugs on bottom plate and sockets for bottom layer of balls are cast in its upper surface.

The base supports case under the rotating band.

ROTATING BAND.

The rotating band, 0.85 inch wide and 0.165 inch thick, is obtained by cutting rings from a seamless drawn copper tube.

The band seat is knurled, 25 teeth to the inch, and the band is first shrunk on this seat with 0.02 inch shrinkage, and then, after assembling of base and case, it is passed through a die to force copper into knurlings.

CENTRAL TUBE.

The central tube is of brass, with dimensions shown on drawing. It is screwed into base of head and its lower end is closed. The object of this tube is to place part of the powder charge in center of shrapnel.

ASSEMBLING.

The base and body, the latter with band shrunk on, are first screwed together, the threads being covered with red lead.

The filling, previously packed and compressed by applying to it longitudinally a pressure of about 10,000 pounds, is then placed in body and the head screwed on.

The preliminary compression of filling is to solidify it, i. e., to produce contact of iron on iron throughout the mass, and should not result in binding the lead balls in their sockets, as this would prevent their free separation on explosion.

An essential feature of the shrapnel requires that in screwing the head to its place close contact should be produced between base of head and top plate of filling, thereby causing the compressed filling to act as a solid mass under the shock of discharge. The pressure due to inertia of filling is borne entirely by the base, and no relative motion of parts of filling takes place.

To secure this contact of base of head with top plate it is generally necessary to place sheets of thin metal or paper between base of head and top plate of filling, the necessary number of sheets being determined by trial in each case.

The total number of balls and individual pieces in a shrapnel complete is 549.

Table of weights and principal dimensions, with allowed variations.

	7-inch shrapnel.		
	Mean.	Maximum.	Minimum.
Weight (without fuse or bursting charge)[a] … pounds	....	123	121
Weight (without fuse or bursting charge)[a] … ounces	....	....	8
Total length … inches	16.625	16.675	16.575
Outside length of head … do	5.075	....	....
Radius of curvature of head, outside … do	8	....	....
Diameter over front of head … do	1.96	....	....
Diameter over base of head … do	6.95	6.955	6.945
Diameter forward of band … do	6.79	6.795	6.785
Diameter over base in rear of band … do	6.95	6.955	6.945
Diameter over band … do	7.12	7.125	7.115
Width of band … do	.85	.855	.845
Distance of band from base … do	1.4	....	....
Interior diameter of case … do	6.39	....	....
Number of separators … pieces	95	....	....
Number of balls	449	....	....
Diameter of balls … inches	.665	....	....
Weight of balls, about … grains	437.5	....	....
Fuse seat.			
Depth to end of thread … inches	1.18	....	....
Diameter of thread … do	1.18	....	....
Number of threads per inch	8	....	....
Powder chamber.			
Interior diameter … inches	4.5	....	....
Interior length on axis … do	4.75	....	....

[a] The total weight of 7-inch shrapnel is 125¼ pounds, including fuse (17 ounces) and bursting charge (30 ounces).

TEST OF 7-INCH SHRAPNEL AT FRANKFORD ARSENAL.

A 7-inch shrapnel of the design herein described was burst in the explosion chamber at Frankford Arsenal—bursting charge 30 ounces—and Plate II shows a photograph of the 637 fragments produced, exclusive of lead balls. Adding the number of balls, 449, the total number of fragments given by this shrapnel is found to be 1,086.

Plate III shows the fragments of a 7-inch shrapnel, differing from the one herein described in that there was no central tube.

The entire bursting charge of 32 ounces was placed in the head, the cavity of which was large enough to receive it. The space occupied by central tube was filled with lead balls and separators, making the total number of these in shrapnel 540 and 119, respectively, as compared with 449 and 95 in the present model The total number of fragments, as shown by Plate III, was 267, and adding to this the number of balls, 540, we have a total of 807 for comparison with the total of 1,086 given by adopted model.

The photographs show very clearly the influence of central powder charge, as evidenced by the more complete breaking up of adopted model.

TEST OF 7-INCH SHRAPNEL, WITH AND WITHOUT CENTRAL TUBE, AT SANDY HOOK PROVING GROUND.

(See record of firing, inclosure 10, O. O. file No. 10077, and blue prints, inclosures 15, 16, 17, and 18, same file.)

Approved and respectfully forwarded to the Chief of Ordnance, United States Army, in connection with 12th indorsement on letter No. 10077—Enc. 3.

J. P. Farley,
Lieutenant-Colonel, Ordnance Department, Commanding.

Frankford Arsenal, Pa., *August 22, 1896.*
(10077)

Record of firing with 7-inch B. L. howitzer (steel), model 1890, No. 15 (weight

[Object of firing: Test of

Date.	No. of fire.	Powder.		Projectile.		Eleva- tion.	Pressure per square inch of bore.	Recoil.	Wind, strength, and direction.
		Kind.	Weight.	Kind.	Weight.				
			Lbs. Oz.		*Lbs. Oz.*	° ′	*Pounds.*	*In.*	
July 21	1	Du Pont's sphero-hexagonal, sample 2, 1896.	8 1	Frankford Arsenal shrapnel, without central tube.	123 5 2 powder, bursting charge. 125 5 total.	1 00	40, 20,300	19	Wind from right and rear, 14 miles an hour; barometer, 30.19; thermometer, 80°; humidity, 79.
July 21	2		8 1	Frankford Arsenal shrapnel, central tube.	125 4 total. 1 14 powder.	1 12	40, 21,400	19	
July 22	3	Du Pont's sphero-hexagonal, U. F., lot 3.	10		126 9	-0 32¼	45, 28,945	19	Wind from rear, 19 miles an hour; barometer, 30.06; thermometer, 69°; humidity, 100.
July 22	4		10	Frankford Arsenl shrapnel, without central tube.	129	-0 32	45, 30,040	19	
July 23	5	Du Pont's sphero-hexagonal, sample 2, 1896.	8 1		125 1 total. 2 powder.	1 12	45, 21,740	19	Wind from rear, 20 miles an hour; barometer, 30.07; thermometer, 77°; humidity, 52.

3,740 pounds), at Sandy Hook Proving Ground, from July 21 to July 29, 1896.

Frankford Arsenal shrapnel.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
The shrapnel grazed the lower part of the screen, and did not burst until it passed through the target. The failure to pass through the screen was due to one of two facts, either that the velocity was lower than that calculated or that the gun has a negative jump on its carriage.	Gun mounted on carriage for 7-inch howitzer. Gun fired at target 39 feet wide by 30 feet high by 1 inch thick, placed 121.7 yards in front of the muzzle. Percussion fuses were used to burst the shrapnel on passing through a screen placed 30 yards in front of the target. This screen was 6 feet high by 8 feet wide by 2 inches thick, and placed with its center about 13½ feet above the ground. The gun was given an elevation calculated so that the shrapnel would have pierced the center of the target had it not burst on passing through the screen. The elevation was afterwards reduced by 6 minutes. The charge was calculated to give a velocity (964 feet per second) at the target equal to the remaining velocity at 1,000 yards, using a full charge.
Screen increased in depth to 7 feet 6 inches. The shrapnel struck the screen 3 feet 6 inches from the top and 3 feet 3 inches from the left edge, and burst after passing through. The number of hits on target as follows: Bullets through .... 360 Bullets imbedded .... 0 Bullets made mark .... 0 Fragments through .... 406 Fragments imbedded .... 38 Fragments made mark .... 6 Total .... 814 Number of pieces as per drawing: Number of balls .... 461 Number of separators .... 104 Case, powder chamber, base ring, and tube .... 5 Total .... 570 36 per cent of the hits on the portion of the target 2 inches thick, through hits. 25 per cent of the hits on the portion of the target 3 inches thick, through hits. 0 per cent of the hits on the portions of the target 4, 5, 6, and 7 inches thick, through hits.	
The shrapnel was recovered whole. Slight bulge in front of band. No marks of rifling.	Fired into a 6-pounder sand butt through a 4-inch screen, placed 6 feet in front of butt.
The shrapnel broke up in sand butt. Head and body in a number of pieces. Base intact. Slight marks of rifling on fragments in front of band.	
The shrapnel struck the screen 3 feet 6 inches from the top and 3 feet 3 inches from the left edge, and burst after passing through. The number of hits on the target as follows: Bullets through .... 432 Bullets imbedded .... 2 Bullets made mark .... 0 Fragments through .... 135 Fragments imbedded .... 12 Fragments made mark .... 14 Total .... 595 Number of pieces as per drawing: Number of balls .... 540 Number of separators .... 119 Case, powder chamber, base, band .... 4 Total 663	

Record of firing with 7-inch B. L. howitzer (steel), model 1890, No. 15 (weight 3,740

[Object of firing: Test of

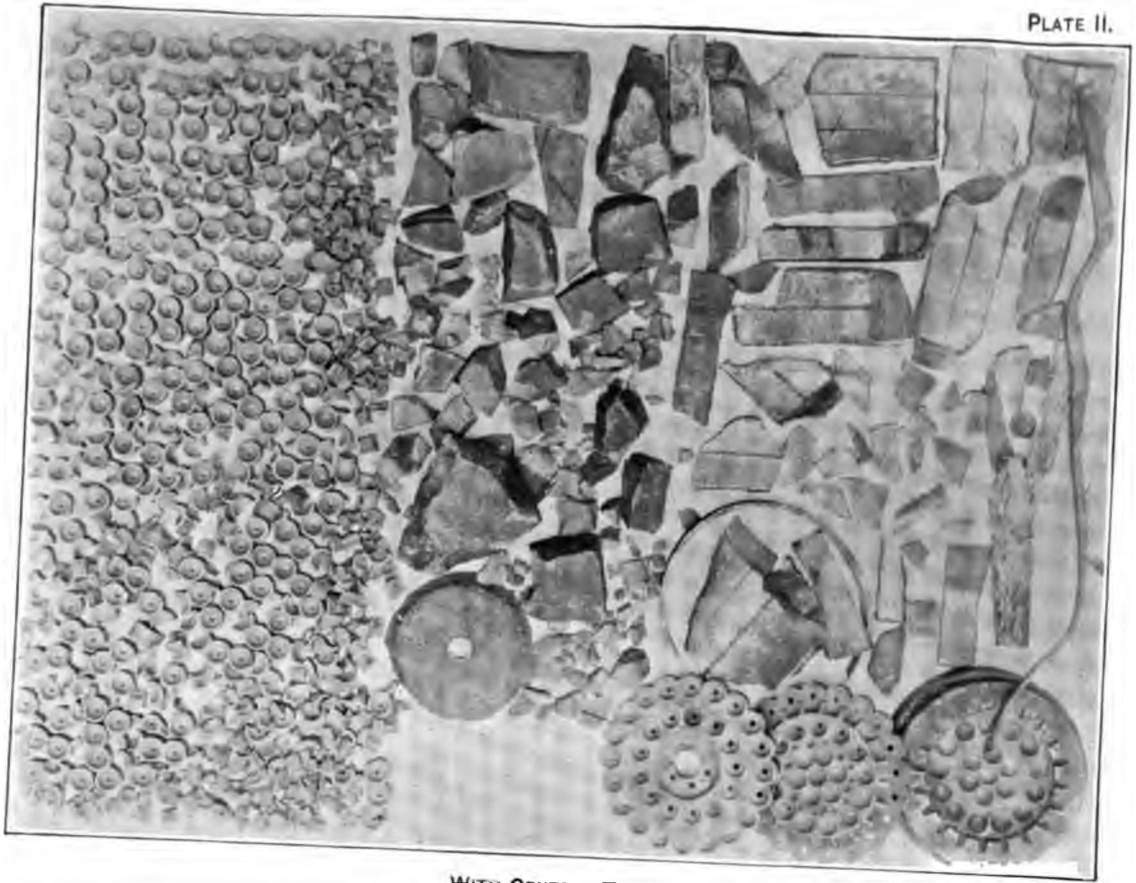
Date.	No. of fire.	Powder.		Projectile.		Elevation.	Pressure per square inch of bore.	Recoil.	Wind, strength, and direction.
		Kind.	Weight.	Kind.	Weight.				
			Lbs. Oz.		*Lbs. Oz.*	° ′	*Pounds.*	*In.*	
July 28	6	Du Pont's sphero-hexagonal, sample 2, 1896.	8 1	Frankford Arsenal shrapnel, without central tube.	122 12¾ 33¼ powder. 124 14 total.	1 20	20,980	19	Wind from rear and right, 40°, 7 miles an hour; barometer, 30.14; thermometer, 92°; humidity, 59.
July 29	7		8 1	Frankford Arsenal shrapnel, central tube.	125 2⅛ total. 1 14 powder.	1 20	25. 21,280	19	Wind from rear and right, 40°, 5 miles an hour; barometer, 30.20; thermometer, 91°; humidity, 62.
July 29	8	Du Pont's sphero-hexagonal U. F., lot 3.	9 12		126 2	—0 35	30, 27,691	19	

pounds), at Sandy Hook Proving Ground, from July 21 to July 29, 1896—Continued.

Frankford Arsenal shrapnel.]

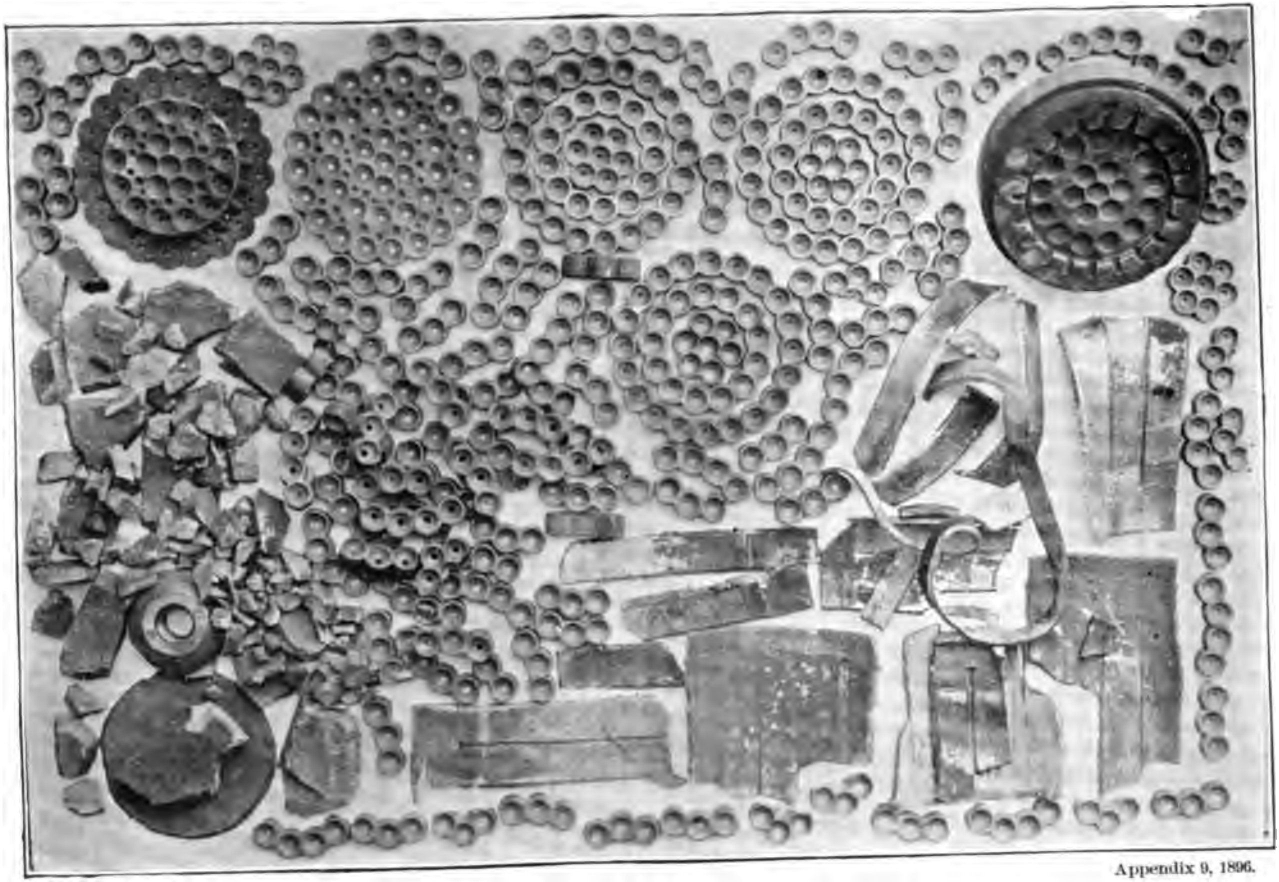
Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
76 per cent of the hits on the portion of the target 2 inches thick, through hits. The 3-inch plank being badly broken up, the number of hits could not be counted. 87 per cent of the hits on the portion of the target 4 inches thick, through hits. 43½ per cent of the hits on the portion of the target 5 inches thick, through hits. 28½ per cent of the hits on the portion of the target 6 inches thick, through hits. 8½ per cent of the hits on the portion of the target 7 inches thick, through hits.	
The shrapnel struck the screen 6 feet 6 inches from the top and 3 feet 9 inches from the left edge, and burst after passing through. The number of hits on target as follows: Bullets through .... 471 Bullets imbedded .... 0 Bullets made mark .... 0 Fragments through .... 109 Fragments imbedded .... 7 Fragments made mark .... 23 Total .... 610 100 per cent of the hits on the portion of the target 2 inches thick, through hits. 62½ per cent on the portion 3 inches thick, through hits. 70 per cent on the portion 4 inches thick, through hits. 10 per cent on the portion 5 inches thick, through hits. 7 per cent on the portion 6 inches thick, through hits. 18 per cent on the portion 7 inches thick, through hits. Number of pieces as per drawing same as round 5.	The elevation was increased slightly over the elevation used with the bursting screen 90 feet from the target. This was done because of the loss of velocity of the fragments of the explosion and of the increased distance of the burst from the target. The screen was placed 150 feet in front of the target. The screen was 9 feet 6 inches high by 8 feet wide by 2 inches thick and placed with its center 12¾ feet above the ground.
The shrapnel struck the screen 6 feet from the top and 4 feet from the left edge, and burst after passing through. The number of hits on target as follows: Bullets through .... 301 Bullets imbedded .... 2 Bullets made mark .... 0 Fragments through .... 201 Fragments imbedded .... 97 Fragments made mark .... 111 Total .... 712 Number of pieces as per drawing same as round 2. 100 per cent of the hits on the portion of target 2 inches thick, through hits. 50 per cent of the hits on the portion of target 3 inches thick, through hits. 100 per cent of the hits on the portion of target 4 inches thick, through hits. 0 per cent of the hits on the portion of target 5 inches thick, through hits. 0 per cent of the hits on the portion of target 6 inches thick, through hits. 11 per cent of the hits on the portion of target 7 inches thick, through hits.	
The shrapnel passed through the 4-inch screen and into sand butt. Recovered whole. A slight bulge all the way around about 1 inch in front of band, and marks of rifling on bulge.	Fired into 6-pounder sand butt through a 4-inch screen placed 6 feet in front of butt. Firing conducted by Lieut. C. L'H Ruggles, Ordnance Department; Frank Heath, Captain Ordnance Department, U. S. A., Commanding; Colden L'H. Ruggles, Lieutenant, Ordnance Department, U. S. A., assistant proof officer.

PLATE II.



WITH CENTRAL TUBE.

PLATE III.



Appendix 9, 1896.

WITHOUT CENTRAL TUBE.

222yds
5½"
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on the
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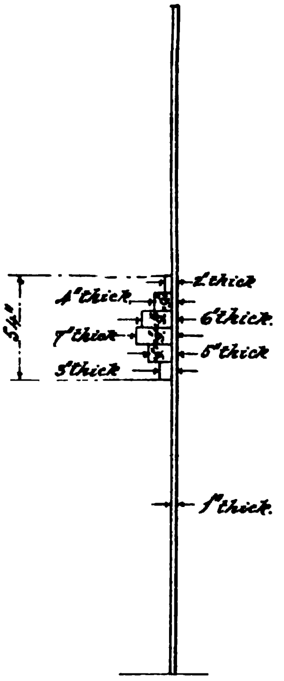
ʼy Hook N.J. July 21st 1896. Round No 2.

222yds–964 f/s–Vel. at 1000yds using full charge.



LEGEND.

✕	BULLETS THROUGH,	369
⊗	" EMBEDDED,	0
○	" MADE MARK,	0
△	FRAGMENTS THROUGH,	406
△	" EMBEDDED,	33
△	" MADE MARK,	6
	TOTAL	814

on the portion of target 2" thick were through hits.

" " " " " 3" " " " "

" " " " " 4" " " " "

" " " " " 5" " " " "

" " " " " 6" " " " "

" " " " " 7" " " " "

ound, July 31st 1896.

Ord 54 2

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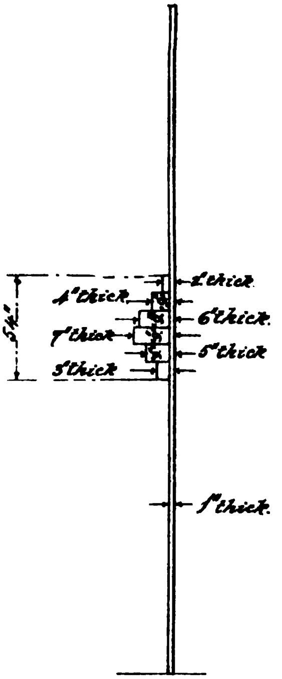
222yd
5ft
on th
ound

Plate IV.

'y Hook N.J. July 21st 1896. Round No 2.

222 yds-964 f/s-Vel. at 1000 yds using full charge.



LEGEND.

X	BULLETS THROUGH,	369
⊗	" EMBEDDED,	0
○	" MADE MARK,	0
△	FRAGMENTS THROUGH,	406
⟁	" EMBEDDED,	33
⧍	" MADE MARK,	6
	TOTAL	814

on the portion of target 2" thick were through hits.

" " " " " 3" " " " "

" " " " " 4" " " " "

" " " " " 5" " " " "

" " " " " 6" " " " "

" " " " " 7" " " " "

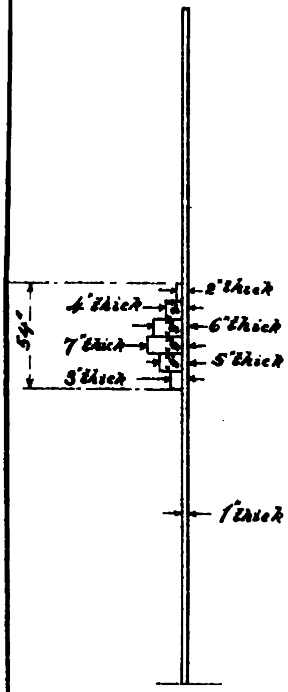
ound, July 31st 1896.

Ord 54 2

y Ho
22yd
54'
7
3
on a
rovs

y Hook N. J. July 29th 1896. Round No 7.

222 yds = 964 f/s = Vel. at 1000 yds using full charge.



LEGEND

X BULLETS THROUGH, — — — — 301

⊗ '' EMBEDDED, — — — 2

○ '' MADE MARK, — — — 0

△ FRAGMENTS THROUGH, — — — 201

△ '' EMBEDDED, — — 97

△ '' MADE MARK, — 111

TOTAL — 712

on the portion of target 2" thick were through hits

. . . . . 3" . . . .

. . . . . 4" . . . .

. . . . . 5" . . . .

. . . . . 6" . . . .

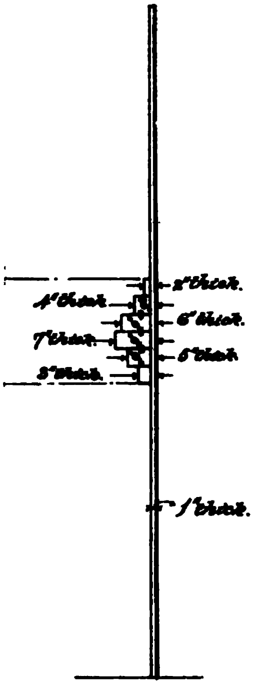
. . . . . 7" . . . .

roving Ground, July 31st 1896.

Ord 54 2

Hook N. J. July 28th 1896 Round No 6

yds – 96.4% – Vel. at 1000 yds using full charge.



LEGEND.

X BULLETS THROUGH, 471.

⊗ " EMBEDDED, 0

⊃ " MADE MARK, 0.

△ FRAGMENTS THROUGH, 109.

△ " EMBEDDED, 7.

△ " MADE MARK, 23.

TOTAL 610.

the portion of target 2" thick were through hits

" " " " 3" " " " "

" " " " 4" " " " "

" " " " 5" " " " "

" " " " 6" " " " "

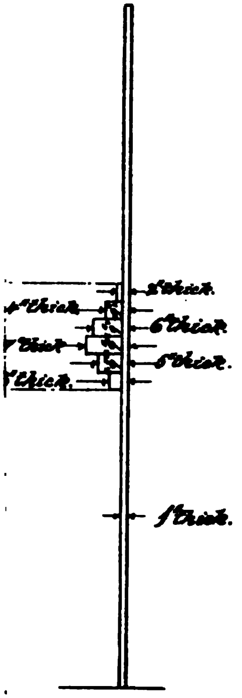
" " " " 7" " " " "

ing Ground, July 31st 1896.

Ord 54 2

Hook, N. J. July 23d 1896. Round No 5.

64% - Vel. at 1000 yds. using full charge.



LEGEND

ULLETS THROUGH.... 432

" EMBEDDED, ... 2

" MADE MARK, ...0

RAGMENTS THROUGH, ... 135

" EMBEDDED, ...12

" MADE MARK, ...14

TOTAL 595

portion of target 2" thick were through hits

dly broken up the number of hits could not be counted.

" " " 4" " " " "

" " " 5" " " " "

" " " 6" " " " "

" " " 7" " " " "

1896.

Appendix 9. 1896

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APPENDIX 10.

RACK PRESS FOR ASSEMBLING 3.2-INCH FIXED AMMUNITION.

(1 plate.)

FRANKFORD ARSENAL,
Philadelphia, Pa., May 20, 1896.

SIR: Pursuant to your verbal directions, I have the honor to submit the following description of a rack press designed and constructed at this arsenal for use in assembling 3.2-inch fixed ammunition.

The following list shows parts of press and their composition:

(Plate 1.)

Parts.	Material.	Parts.	Material.
A—Body	Cast-iron.	G—Handle bars	Steel.
C—Hinged locking ring		H—Counterweight pulley	Cast iron.
D—Rack slide	Steel.	I—Pulley support	Steel.
E—Rack slide head	Steel.	K—Counterweight	Lead.
F—Pinion shaft and pinion (including nut and washer).	Steel.		

BODY.

To support press, the cast-iron body A provides a base 14 by 17 by 2 inches thick, with four holes for bolting to floor.

In the upper surface of this base is the seat B, for supporting and centering head of cartridge case. It is slotted to receive primer safety guard.

The body also provides housings for the rack slide E and the pinion shaft F. A lug, which is part of the casting, forms half of the hinged locking ring C, which in connection with the projectile seat, B, keeps the case centered and well supported. A similar lug, without hinged attachment, and shown on drawing above locking ring C, furnishes, in connection with recess in head of rack slide, means for centering and steadying projectile.

RACK SLIDE.

This is made of steel and the rack has six threads per inch. The attached head E is recessed to receive the Frankford Arsenal combination fuse. Contact of head with projectile takes place along ogive of the latter so that the fuse is not subjected to any pressure. Except when it is forced down by pressure on handle bar, the rack head is kept clear of projectile by the counterweight.

PINION SHAFT AND PINION.

The pinion shaft and pinion are formed from a solid piece of steel. Lateral play is prevented by shoulder on shaft and nut and washer at end. The larger end of shaft is squared for attachment of handle bars.

HANDLE BARS.

The handle bars are made of steel, forged to fit squared end of pinion shaft, and secured in place by a set screw. The distance from center to end of bar is 20 inches.

It was found by test that one man could supply the force necessary to force projectile into case.

The inside diameter of mouth of case is about 0.01 inch smaller than diameter of base of projectile.

The projectile is forced 1.7 inches into the mouth of the case.

The cartridge then has more than the stiffness deemed necessary for transportation in limber chests.

A photograph of press, showing rack slide raised after forcing projectile to its place, is submitted herewith.

Respectfully,

B. W. Dunn,
Lieutenant, Ordnance Department, U. S. A.

The Commanding Officer, Frankford Arsenal, Pa.

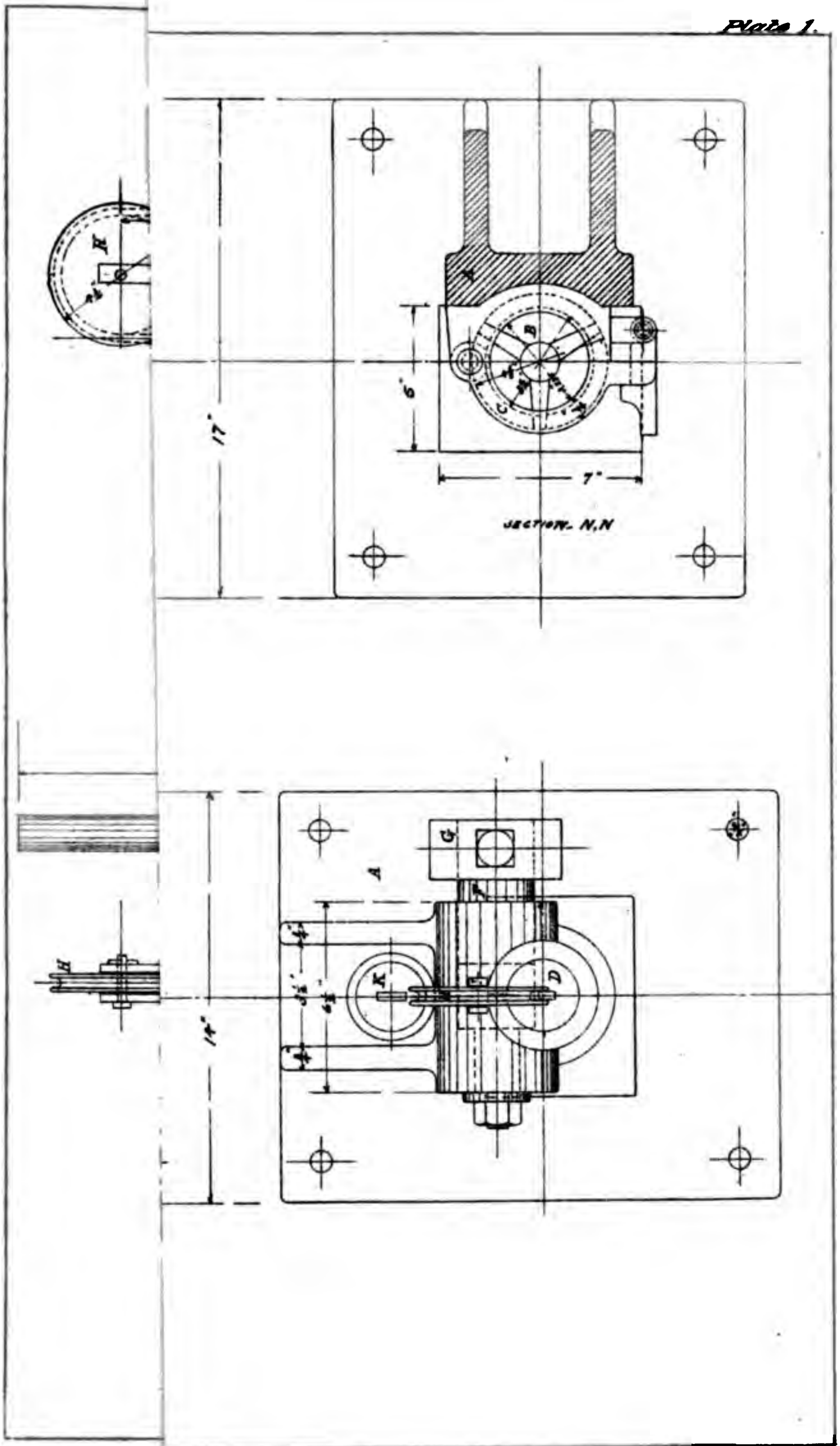
Frankford Arsenal,
Philadelphia, Pa., May 21, 1896.

Approved and respectfully forwarded to the Chief of Ordnance, United States Army, in connection with 3d indorsement on letter No. 6466—Enc. 12.

J. P. Farley,
Lieutenant-Colonel, Ordnance Department, Commanding.

(6466)

Plate 1.



Appendix 10 1896.

Ord 54 2

APPENDIX 11.

REPORT OF PRINCIPAL OPERATIONS AT WATERVLIET ARSENAL FOR THE FISCAL YEAR ENDING JUNE 30, 1896.

(7 plates.)

WATERVLIET ARSENAL, *August 24, 1896.*

SIR: I have the honor to submit herewith my report of the principal operations at this arsenal during the fiscal year:

GUN CONSTRUCTION.

During the fiscal year work on gun construction has progressed as steadily and satisfactorily as the condition of the funds for finishing and assembling seacoast guns would permit. The depleted condition of the appropriations for this purpose compelled, however, the discharge of a small number of employees in December, 1895, followed by an increasing number in succeeding months, until by April and May, 1896, the shop was running at but slightly over one-half of its full capacity. Endeavoring to keep the principal gun lathes in operation and limiting the work to the operations which required considerable time for their completion, caused this reduction to fall most heavily upon the sections engaged in finishing parts of breech mechanism, and as a result the number of guns assembled, but retained in various stages of completion, was much greater at the end of this year than the preceding.

In all ten 8-inch, nine 10-inch, and nine 12-inch B. L. rifles have been entirely finished and assembled, and, in addition, a number of guns advanced to completion, which is in excess of the number unfinished a year ago, and equivalent to 3.45 8-inch guns, 4.3 10-inch guns and 1.85 12-inch guns. Including this work done with the number of guns actually completed would give as the output of the gun factory for the past fiscal year the equivalent of 13.45 8-inch guns, 13.3 10-inch guns, and 10.85 12-inch guns, or 37.6 seacoast guns in all, an amount slightly in excess of the product for any of the preceding fiscal years.

In addition to these heavy guns, ten 5-inch B. L. siege rifles, ten 7-inch howitzers, and ten 3.6-inch mortars have been finished, and six 7-inch mortars very nearly completed. Three 3.2-inch rifles have been converted to rapid-fire guns upon the Dashiell, Fletcher, and Seabury systems, respectively, and a 3.2-inch Gerdom rapid-fire gun has been manufactured.

A 12-inch B. L. mortar has also been altered from the original breech mechanism to the Farcott-Stockett design, and a 4.7-inch Hotchkiss gun is in process of modification to the Gerdom system.

The trunnion hoop of one of the 5-inch B. L. rifles made in previous years having cracked in proof, it was removed and a new trunnion hoop substituted. A similar operation upon a second gun has been partly performed.

Six breechblocks with carrier rings complete for 3.2-inch rifles have been made to meet possible repairs or issues, and also a large number of smaller parts of breech mechanism for different guns. Split rings for the 12-inch cast-iron mortars now in service were made and issued, and a large number of improved locking plates and locking bolts for the seacoast guns which had been issued in previous years or were still in process of manufacture at this arsenal.

The fabrication of inspecting instruments, jigs, and gauges to insure accurate completion of the work and interchangeability of parts of breech mechanism has been carried on during the year, and the equipment in this respect is now nearly completed. Special attention is now being given to this important feature of the breech mechanism; all parts are very carefully inspected and every effort made to obtain the utmost accuracy in the finished work, and as a result it has recently been found that a number of breech mechanisms could be assembled indiscriminately with the various parts.

During the last month of the fiscal year the increased appropriations that had then been made by Congress permitted the resumption of work to the full capacity of the shop, and it is now progressing in an exceedingly satisfactory manner, and as soon as some recently designed and additional features of the breech mechanism can be completed and adapted to the guns now here, a large number of those that remained completed at the end of June can very soon be issued to the Sandy Hook Proving Ground for test.

CARPENTER, MACHINE, AND PROJECTILE SHOPS.

A limited amount of work has been performed in these shops during the year, consisting mainly of that required in connection with gun construction and with the repair and construction work in progress.

The principal special items of work which have been performed are the manufacture of 10 carriages (steel) for 3·6-inch B. L. mortar; 30 sets of implements (incomplete) for 3.6-inch mortar, 5-inch siege rifle, and 7-inch howitzer; 11 platforms (complete) for 3.6-inch B. L. mortar carriages; 24 implement chests and 18 tool chests for 3.6-inch B. L. mortars (steel); rebanding and retapping for "C" fuses for 3.6-inch shell on hand, and the banding, painting, and packing ready for issue of 983 8, 10, and 12 inch A. P. shot, and 717 D. P. shell.

BUILDINGS, PLANT, AND OTHER CONSTRUCTION WORK SINCE MY LAST REPORT.

GUN FACTORY.

The equipment of the south wing for the manufacture of 16-inch guns will be finished before the expiration of the present calendar year, all of the machinery having now been delivered and erected. The completion of the rifling machine, the jacket lathe, and of three hoop lathes, forming part of the 16-inch gun plant, was mentioned in my last annual report. Since that time the threading and slotting machine for breech screws of 16-inch guns has been erected and completed; its former screws and nuts have been delivered, but will not be threaded until the Department decides in regard to the exact pitch they are to have.

All of the 16-inch gun lathes contracted for on January 25, 1894, have been delivered and put in place by the contractors. Three of these gun lathes have been belted up and their back-rest bearings and boring-bar-rest bearings are now being finished, bored, and turned in place. Work on the shafting and belting for these lathes is nearing completion. Throughout this plant the necessary number of friction clutches has been provided, so that the whole or any part of it may be thrown out of connection as desired.

The interior cylinder of the jacket-heating furnace has recently been replaced by a new one, the old cylinder having been partly destroyed by the action of the heat after being subjected to a continuous and sometimes forced service of about five years. The necessary extension of the hoop furnace, to which I referred in my last annual report, has also been completed.

Complying with recent instructions from your office, I have submitted plans and a description of a heating furnace for shrinkage purposes which is to be operated by means of oil gas. This furnace, if its construction is authorized, can best be located in the southeast corner of the shrinkage pit, directly opposite the present jacket furnace.

It will be seen from the accompanying drawings (Pls. I and II) and from the description contained in the inclosed report that this proposed furnace will be of such proportions as to admit of heating and handling the largest forgings for 16-inch guns in the simplest manner as well as those for smaller calibers. The drawings indicate also the proposed location of oil tank and gas producer.

This furnace promises good results, and its construction should be begun at an early day. The existing coal furnaces should also be maintained for use during any possible repairs to the proposed oil furnace, or to supplement the latter whenever a large number of shrinkages are in progress.

The extension of the boring bars of six hoop lathes in the south wing for the boring of hoops of 12-inch guns, model 1888 M II, was completed some time ago. The new skeleton reamer heads referred to in my last annual report are a complete success, and a number of them are now in use; but on account of the attention which had to be given to the output during the past year the contemplated trial of metallic packings in place of wood packings had to be postponed. All important gauges and templets required to secure uniformly good operation of the breech mechanism of different guns and the interchangeability of such parts as are subject to wear or injury have been completed, and some of those of lesser importance are in the process of manufacture.

In my last annual report I called attention to the fact that it may become necessary soon to replace some of the smaller lathes in the north wing. The same remark applies also to some of the lathes in the small gun shop. Some of the latter have seen many years of hard service, and the wear on these machines increases the cost of the very accurate work which has to be done in them. To replace such inexpensive tools at the proper time seems in the interest of economy.

WATER-POWER PLANT—ELECTRIC LIGHT AND POWER PLANT.

The new water-power plant described in my last annual report was finished last autumn, and has since been in successful operation. The general features of this plant, which is consolidated with the electric light and power station in the shops below the Eriè Canal, are shown in the accompanying photographs (Pls. III and IV), the former showing the principal features of the plant, including the electrical part, located on the main floor of the machine shop, and the latter the turbines, water-service pumps, and accessories, which are situated in the basement.

It became necessary to operate this power plant during the greater part of last winter from the gun shop by means of electricity, in order to run the lower shops and the water-supply pump, as the water was withdrawn from the Erie Canal for a considerable time by the State authorities for the purpose of surveys and repairs. Under such circumstances it is more economical to run the lower shops and the pumping station electrically from the gun shop than to operate the existing independent steam-power plant for this purpose.

Freshets which occurred on two different occasions during the past winter caused backwater to rise several feet above the basement floor on which the turbines are located. This caused a complete stoppage of the water power for about a week in each case, during which time the lower shops were run entirely by electricity from the gun shop. These incidents illustrate plainly the importance of the provisions, made originally in installing the electric light and power plant, for running one of the generators in the lower station as a motor, with current supplied from the station in the gun shop.

The motor capacity of this generator is about 55 horsepower. The requirements were, however, on several occasions considerably in excess of this, especially on account of an increased demand for water supply resulting in a heating of certain parts of the electric plant, not to a dangerous degree, but sufficient to induce me, for the sake of safety and economy, to make the necessary arrangements whereby the second generator in the lower station can also be operated as a motor simultaneously with the other machine.

The electric light and power plant has had another year's trial since my last report, with very gratifying results, which can best be expressed by saying that since its establishment the only repairs made consisted in smoothing off some of the commutators.

The present inclosure of the power plant consists of a light framework, whose lower portion is covered with wire netting. A permanent inclosure, in the form of a framed partition, with glazed sashes in the upper portion, is much needed, because the electric machinery of the power plant should be kept free from dust, which is not possible at present. Furthermore, a permanent inclosure is necessary to permit of maintaining a suitable temperature in the station for the operator of the lighting plant during winter nights, without keeping the temperature of the whole shop up to that degree during the night. For this reason the turbines and pumps in the basement will have to be similarly inclosed and separated from the remainder of the basement.

The estimated cost of this work will be about $600.

WATER SUPPLY.

The new water tower, with its equipment and the necessary connections, has been completed to the extent of the appropriations, and has been in operation for several months. An independent and satisfactory supply of water for the operation of the shops, and to a certain extent for fire protection, has been thus established, but to solve the problem completely it will be necessary to create a subdivision of the existing water-service system, as stated in my last annual report, so as to supply quarters, offices, etc., with pure water fit for drinking purposes. This can be accomplished by supplementing the system of distributing pipes on the post with a 5-inch main and by procuring a new tank for the water tower, to contain doubly filtered water for domestic purposes.

Considering the water supply of the post further, especially in connection with an efficient system for fire protection, I believe that a great deal could be accomplished in this direction if the 5-inch force main between the pumping station and the water tower were connected with the 6-inch distributing main. This pipe is located north and east of the lower shops; it has a connection with the city main near the main gate and with the 8-inch distributing main of the post near the north bridge leading to the officers' quarters, the stables, gun shops, and finally to the water tower. If this connection were made, it would present two advantages: First, in the event of an accident or repair to the 5-inch force main, the post could be supplied without the loss of time by means of the 6 and 8 inch distributing mains; second, in case of fire, all of the force pumps, whose capacity is more than double that of the 5-inch force main, could be operated simultaneously, and water could be forced through both force and distribution mains simultaneously. The importance of this feature is so obvious that it is earnestly recommended the proposed connection be made at an early day. Present appropriations will be sufficient for this purpose.

FIRE PROTECTION.

The proposed system for fire protection has been inaugurated during the present fiscal year, but the sum appropriated was only sufficient to procure a few of the most needed appliances.

A No. 1 American steam fire engine was procured from the American Steam Fire Engine Company, of Seneca Falls, N. Y., for the sum of $4,200.

Two hose carts, each capable of carrying 600 feet of 2½-inch fire hose, were also furnished by the above company for the sum of $200.

One thousand two hundred feet of 2½-inch cotton fire hose were furnished by Wendell & McDuffie for the sum of $864.

The balance of the appropriation of $6,000 was expended for the installation of an electric fire-alarm system. This consists mainly of two stations equipped with alarm bells and annunciators and 10 fire-alarm boxes judiciously distributed among the buildings on the post. One of the stations is in the guardhouse and the other in the stable building. The latter contains the fire engine, hose carts, etc. The two stations are about 1,200 feet apart, and they are so connected electrically that the alarm bells and annunciators function simultaneously in both. The accompanying inclosure (Pl. VI) shows the location of the ten fire-alarm boxes and the two stations.

With the additional appropriation of $5,919.75 (this being the difference between the estimate submitted to Congress and the first installment of the appropriation made at the last session of Congress) it is expected to complete the arrangements for fire protection by procuring a ladder truck, stationary hose racks in the shops, stationary ladders for access to the roofs of the gun shops, an extension of the distribution main around the south wing of the gun shop, and an increased number of hydrants. The present quantity of fire hose will have to be further augmented.

COAL STORAGE BINS, AND ARRANGEMENTS FOR THE HANDLING OF COAL.

The coal storage bins erected during the past year are located directly west of the boiler house of the gun shop; their construction, and that of the trestles and embankments, forming the approaches, is shown in the accompanying plates (VII, VIII, and IX).

The foundation of the coal bins is made of concrete, the superstructure is a combined construction of iron and wood; the framework and the supports of the railway tracks are made of I-beams and the bracing is of angle iron. This insures great rigidity and endurance, and reduces the cost for maintenance to a minimum. The top of the storage bins is boarded in to keep the snow out, and suitable trapdoors are provided to unload coal from dump cars as well as by hand from ordinary coal cars. In the center of the structure and beneath the sloping floor of the coal bins is a passage, through which a narrow-gauge spur passes and leads into the boiler house. Two iron charging cars, capacity 1 ton, are provided for handling coal and ashes. A number of iron gates are arranged on either side of the central passage for filling the charging cars. They are pushed into the boiler house by hand and are run first on a siding which contains a 2-ton Fairbanks platform scale, for weighing the coal. Subsequently, the car is put on the track running parallel to the boiler fronts. The side of the car box facing the furnaces swings on hinges, and when lowered permits the shoveling of coal from the car direct into the furnaces. The charging cars are also used for the removal of ashes from the boiler house.

The coal storage capacity of the gun factory is about 3,000 tons, viz, 1,500 tons in coal storage bins and 1,500 tons between and beneath the trestles.

SEA WALL ON THE HUDSON RIVER.

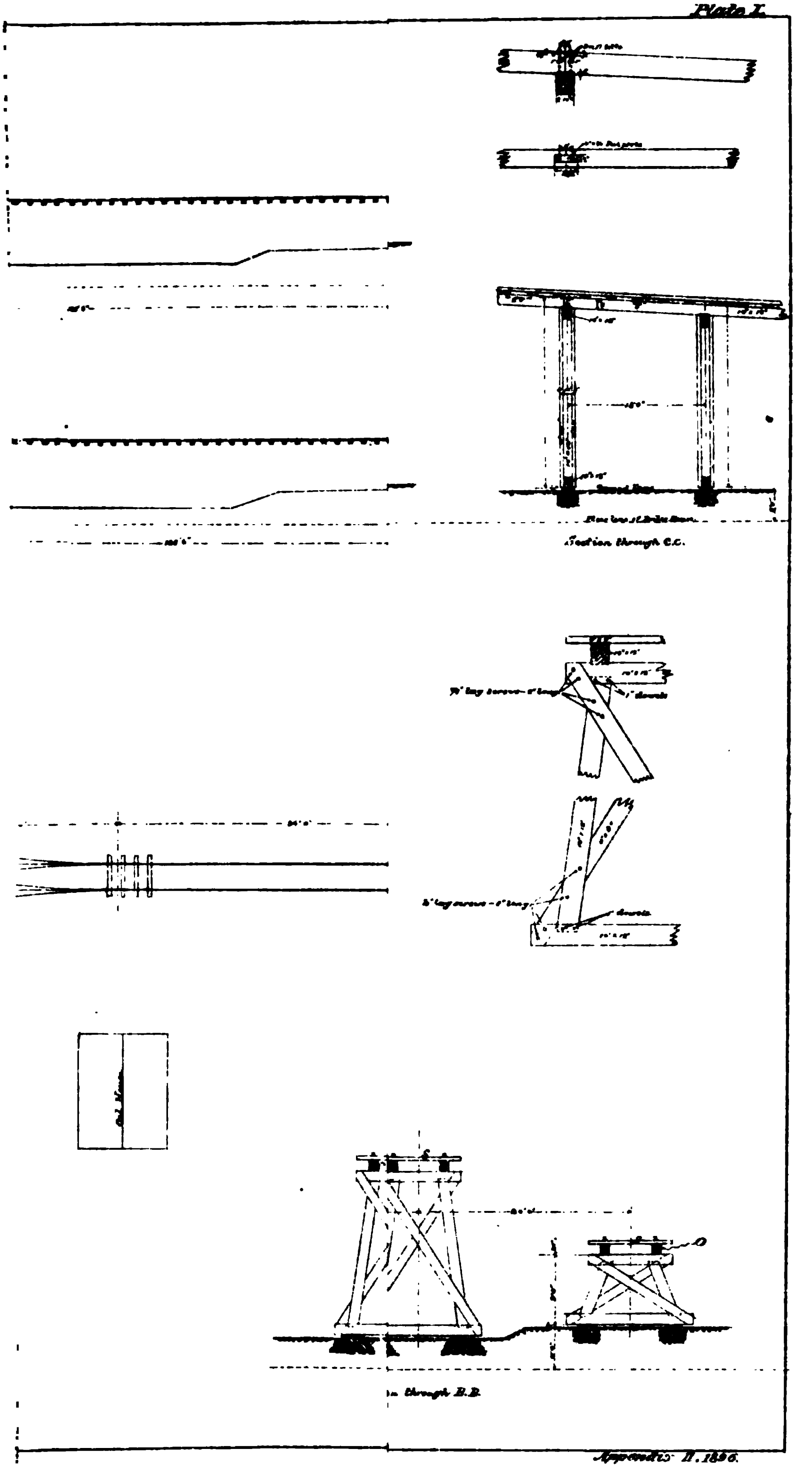
I have the honor to again call your attention to the necessity of extensive repairs to the masonry of the sea wall on the Hudson River and the culvert at the north end of the arsenal grounds. I reported a year ago that this masonry was in bad condition, and the freshets of last winter have caused further injury. The amount asked for in my annual estimate to make the necessary repairs is urgently needed.

Isaac Arnold,
Major, Ordnance Department, U. S. A., Commanding.

The Chief of Ordnance, United States Army,
Washington, D. C.

(10104—Enc. 12)

Plate I.



Appendix II. 1896.

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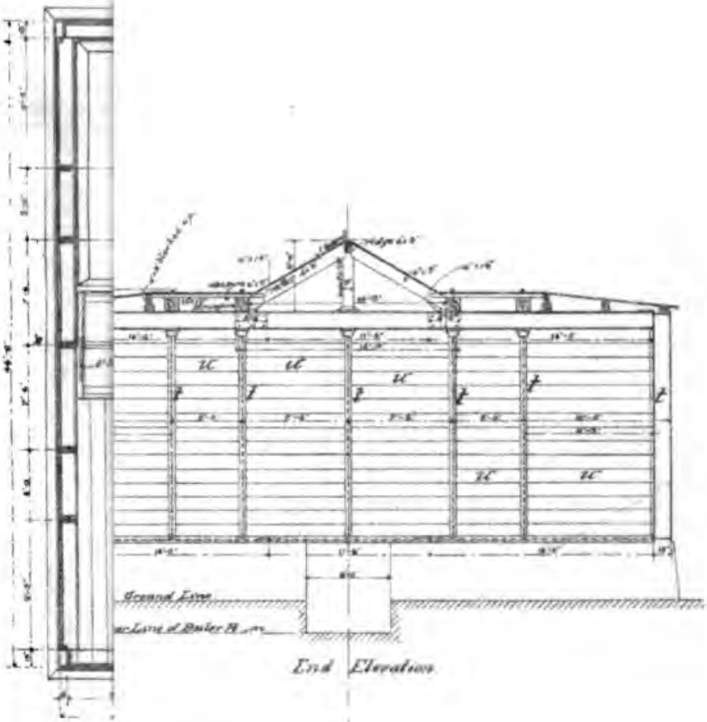
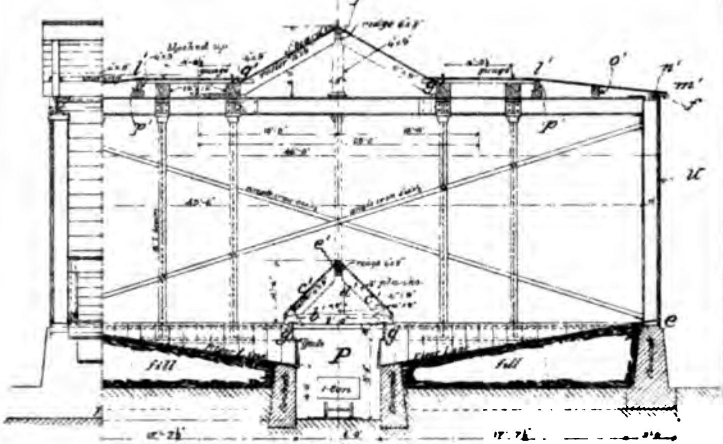
Plate II



End Elevation



Section on "B B"

Appendix II, 1896

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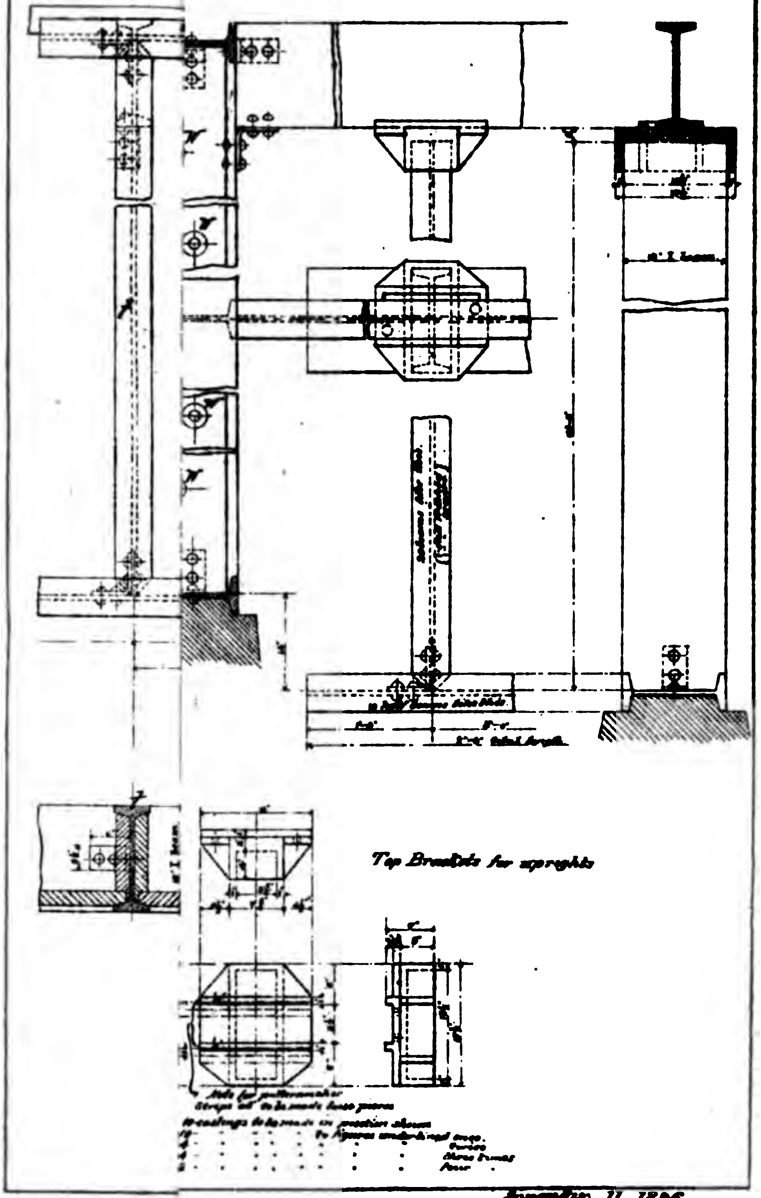
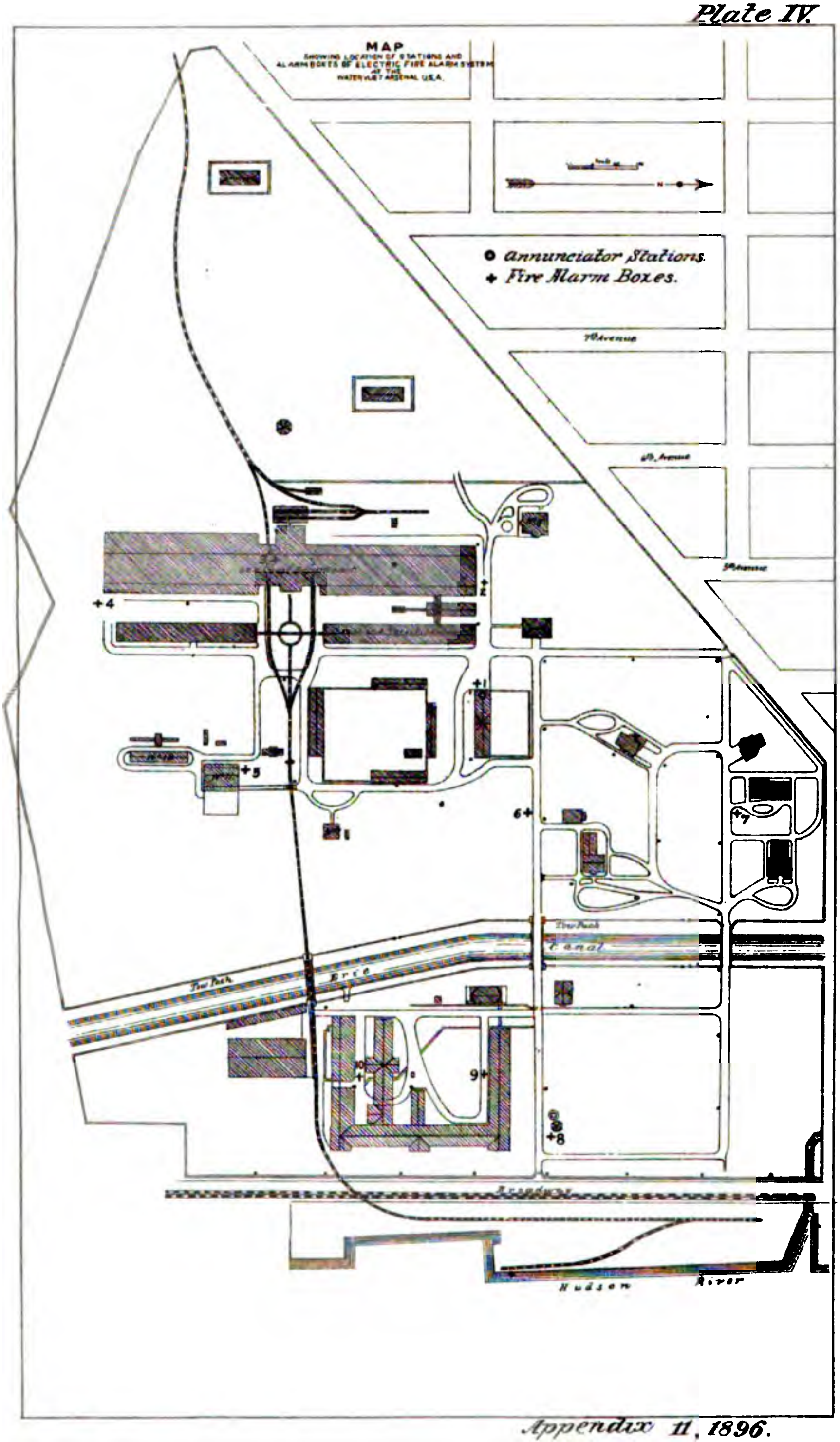

Top Brackets for uprights
Hole for pattern maker
Strips to be made loose pieces
10 castings to be made in position shown
Twice
Three times
Four
12" I beam
8'-0" total length

Appendix 11, 1896.

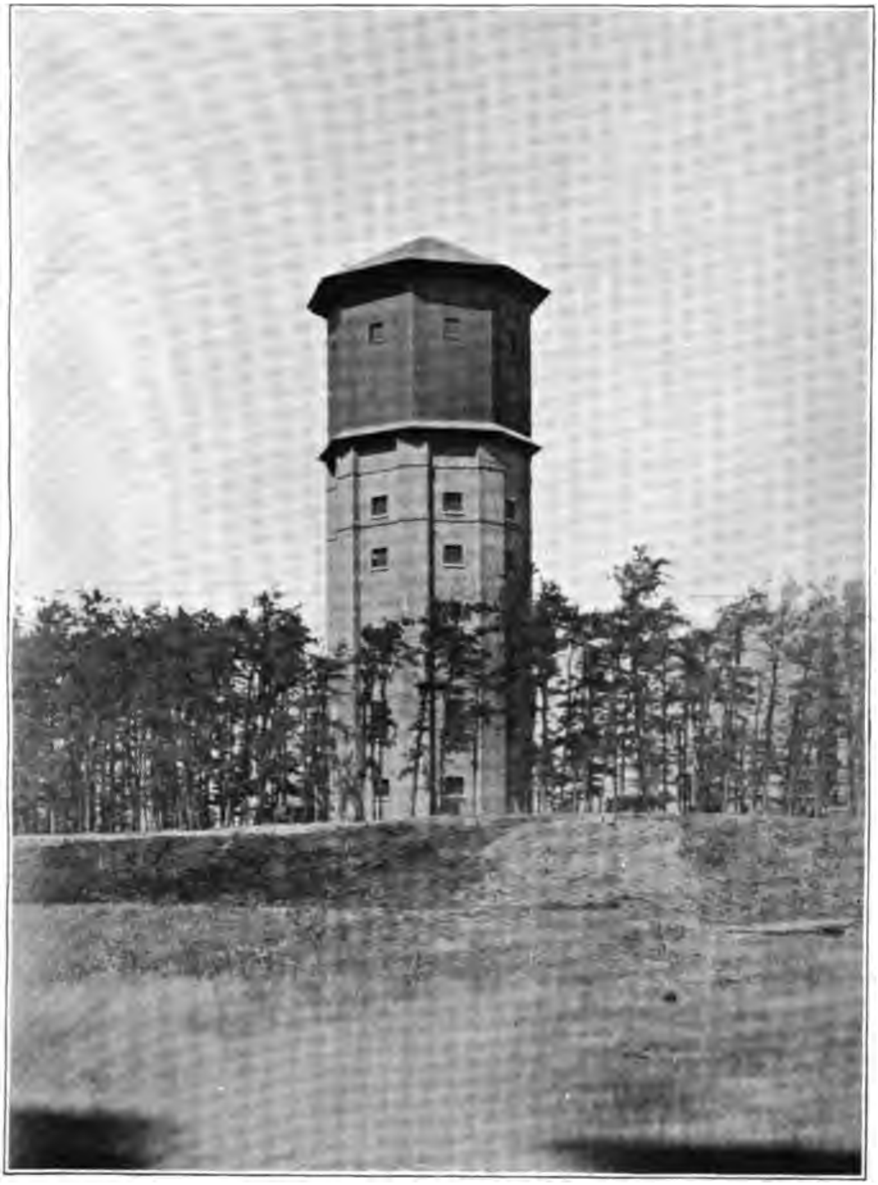
Ord 54 2

Plate IV.

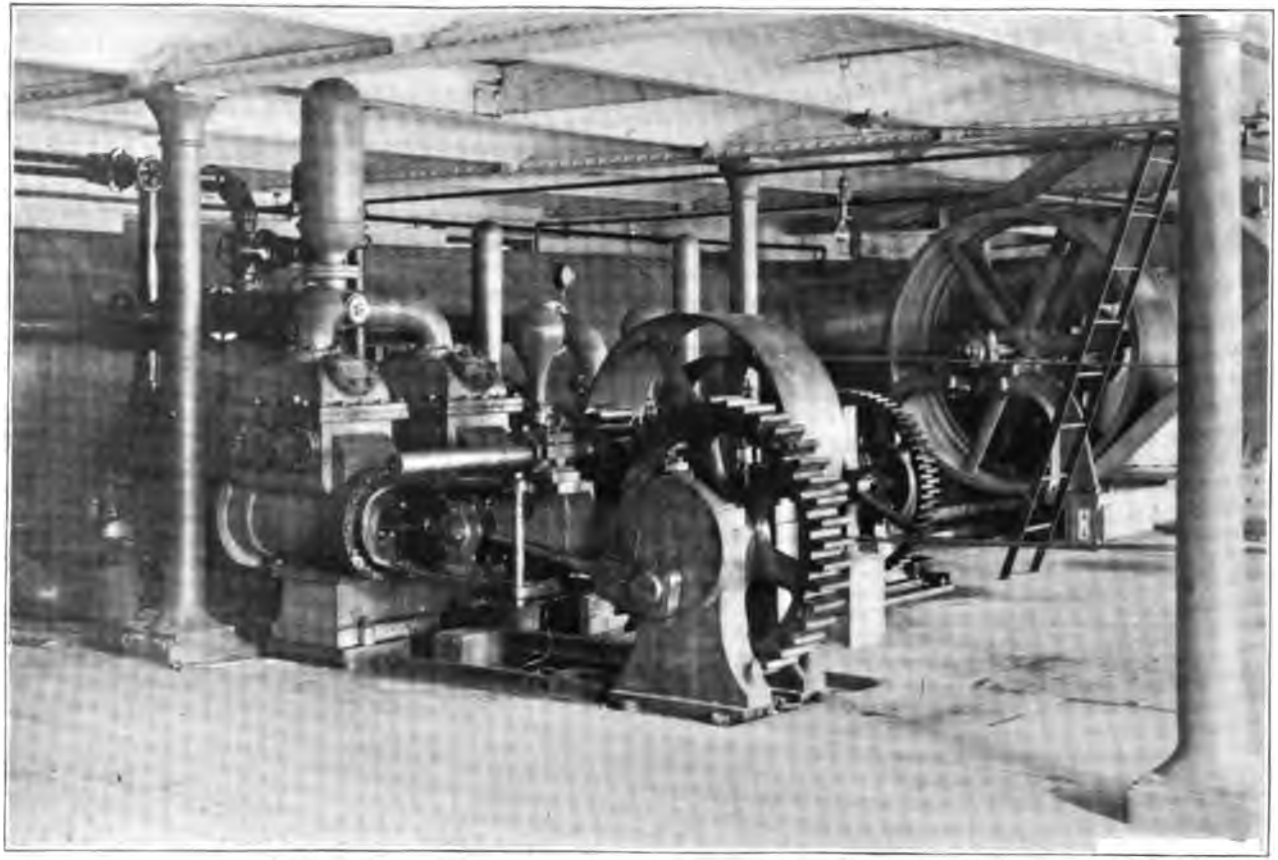


Appendix 11, 1896.

Ord 54 2

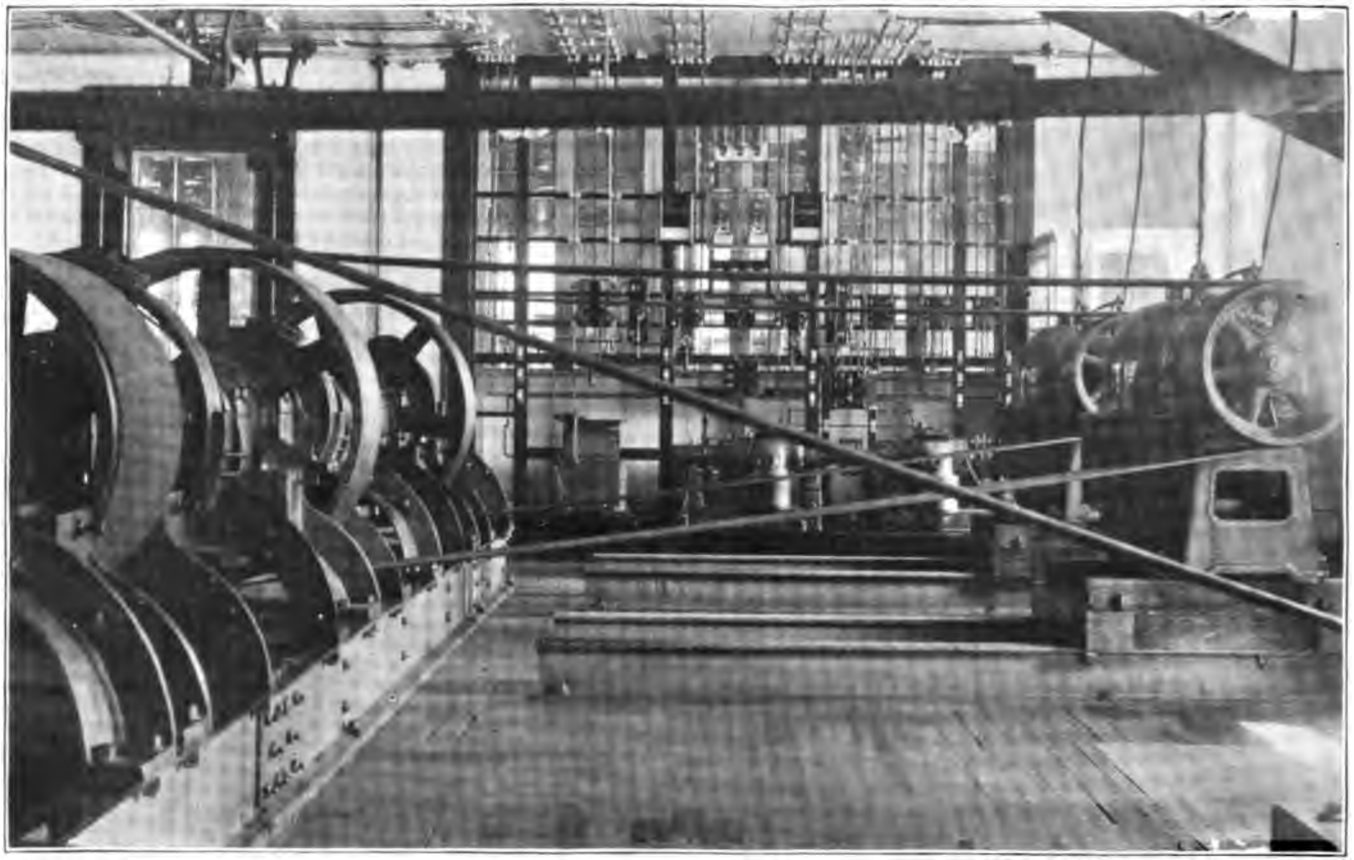


EXTERIOR OF WATER TOWER, WATERVLIET ARSENAL.



BASEMENT OF POWER PLANT IN LOWER SHOPS, WATERVLIET ARSENAL.

PLATE VII.



Appendix 11, 1896.

MAIN FLOOR OF POWER PLANT IN LOWER SHOPS, WATERVLIET ARSENAL.

APPENDIX 12.

DESCRIPTION OF OIL-GAS FURNACE, BY A. VICTORIN, CONSTRUCTING ENGINEER.

(2 plates.)

WATERVLIET ARSENAL,
Watervliet, N. Y., June 27, 1896.

SIR: In compliance with your instructions I have the honor to submit herewith designs for and an estimate of the cost of a furnace for shrinkage purposes to be operated by means of oil fuel.

Before entering into a description of this furnace, I wish to make a brief statement concerning the use of oil as combustible for furnaces, which is based on my observations during the past years as well as on a recent careful study of the systems and appliances foı the combustion of oil fuel in commercial use.

The old method of the injection of oil into heating furnaces by means of mere burners did not meet with practical success on account of the difficulty of obtaining a uniform temperature. The jet thrown into the furnace consists in this case of a mixture of oil, oil gas, and air or steam. The intensity of the flame produced in this manner will destroy all metal parts which come in immediate contact with it in a short time. The burners as well as such parts of the furnace which are in reach of the flames are soon covered with a greasy residue from which numerous troubles arise.

It is not possible to obtain a uniformly diffused heat in a large furnace especially by this method, inasmuch as the conversion of the oil into gas (preceding combustion) is confined to the locality of the jet, producing a flame of considerable local intensity.

The direct injection of oil is therefore not suitable for the purpose in question.

There are three different devices for the injection of oil into furnaces, which I found in commercial use. They are illustrated in the accompanying circulars, marked A, B, and C, and are (1) the Bradley gas generator, (2) the improved duplex system, and (3) the aërated fuel process.

The first system is represented by the burner only, without showing oil tank, pumps, blower, etc. The burner is what may be termed a steam injector. The inventor's statements were not clear enough to impress me with confidence. It will be seen from the illustration that oil and steam are separately supplied to the burner under pressure, while the air is admitted through a central passage under atmospheric pressure. The burners or machines, as the inventor terms them, must be arranged in such a manner in the furnace that they can be heated red by the deflected flame, in order to convert the oil into gas in the fixing chamber before its ejection, and a jet of steam is used to produce the necessary intensity of the flame. But steam is not a combustible and its decomposition is rather costly. Satisfactory results are only obtainable by a perfect mixture of gas and air in the proper proportions and under well regulated pressures, and the spraying by steam is entirely impracticable for a shrinkage furnace.

In this respect the other two processes mentioned are certainly a great deal better than the steam injector. Properly adjusted to forge fires and some other furnaces in which an intense heat is used without regard to nice regulations, this aërated fuel is used to advantage, but there is no instance within my knowledge where this plan has been successfully applied for work requiring a moderate, even, constant and well regulated temperature, under easy and perfect control.

Gas is the only fuel by means of which this can be accomplished, because the injection can be regulated to a nicety. The focus of the flame, its length, and intensity or mildness depend upon controllable pressure of wide range whose minimum should be only slightly above no pressure, to be able to obtain moderate temperatures also. Only in this case can the temperature be steadily maintained, and instantly increased or decreased, according to the will of the operator.

I have never succeeded to obtain knowledge of a means of using petroleum, either crude or refined, which would give approximately as good results as gas. The reason for this is that oil and air can not be fed in the exactly proper proportions to the burner, such as will result in immediate perfect combustion at the point where it enters the furnace.

Of the two methods employed to spray oil into the furnace—one by force of steam, the other by compressed air—the latter is undoubtedly, and for obvious reasons, the better method, but it suffers from one radical defect. The proportions of oil and air can not be varied with sufficient accuracy to produce and maintain different temperatures at will; in fact, the aërated fuel, as it is called, requires that the burner or burners applied in heating a given space be accurately adjusted so as to produce within that space a given temperature, and the relative proportions of oil and air injected can not be materially varied, so as to increase or diminish the heat.

The usual pressure under which such burners spray and inject the oil is about 16 pounds to the square inch. This pressure is necessary to produce a sufficiently fine spray, and thus produce a momentary mixture of oil spray and air of proper proportions for instantaneous and approximately perfect combustion.

When the heat thus generated has reached its maximum degree of intensity and it is desired to reduce the temperature below such maximum, the only practical means would be the checking of the pressure and its reduction below a point where it will properly atomize the oil. These observations derived from the practical experience with this process led to the conviction that the oil must first be converted into a gas which could instantly combine, mix, and become one body with the air blast.

Gas and air can be easily mixed in definite proportions, governed by two valves, and it is only a question of proper burners and proper pressure on both to produce heat which can be controlled with absolute accuracy, by varying the supply of both always in proper and definite proportions. This can be perfectly and satisfactorily accomplished by means of the system and apparatus of the American Gas Furnace Company, a descriptive catalogue, marked D, of which is herewith submitted.

Their oil-gas machine converts the cheapest grade of refined petroleum into a fixed gas. The catalogue explains the principles upon which the gas is made and the general features of the apparatus. It contains, also, on page 33, a report which was published in the Journal of the Franklin Institute of November, 1894. As to the safety of the apparatus, I call attention to a testimony, on page 16, of Dr. Henry Morton, president of the Stevens Institute of Technology. It appears that this apparatus has found favor not only in this country but in Europe also, and I was informed that it was in use to a great extent at the Woolwich Arsenal.

There is little doubt in my mind of accomplishing by means of this process the work required. It is on a larger scale than has ever been done before, and while the details of the construction must be well thought out on this account, I am confident of a successful solution of the problem as submitted.

The general features of the operation of this system are as follows:

1. The making of gas from naphtha as described in the inclosed catalogue of the American Gas Furnace Company.

2. The delivery of that gas under a pressure of about 1 pound per square inch to each of the burners indicated in the drawing, each burner being under separate control by means of a valve.

3. The delivery of air under exactly the same pressure (1 pound per square inch) to the same burners.

4. The even pressure of both the gas and air permits the checking of the combustion, after the furnace becomes heated to the proper degree, so as to maintain the desired temperature.

I wish to state finally that naphtha gas is a pure hydrocarbon, containing no sulphur. By turning on a slight surplus of gas over and above what is necessary for combustion with a certain quantity of air, the whole furnace contains a nonoxidizing atmosphere, because no air enters the furnace which is not surcharged with carbon. I wish to call attention to the fact also that this gas is regularly used for illuminating purposes.

The proposed shrinkage furnace, with its necessary adjuncts, is shown in the accompanying tracings (Pls. I and II).

Pl. I shows the location of the oil-storage tank A, the oil-gas apparatus B, and the gas furnace C.

The capacity of the oil-storage tank is about 8,000 gallons. This is slightly more than the capacity of an oil-tank car (which is 6,000 gallons), which surplus capacity is necessary, for obvious reasons.

Estimating a maximum hourly consumption of 3,000 cubic feet of illuminating gas per hour, which will be supplied by 15 gallons of 76° naphtha, the capacity of the oil-storage tank will be sufficient for about 6 weeks, working the furnace 10 hours each day.

The oil-gas machine will cover a floor space about as indicated, beneath a stairway.

It will be best to erect the gas furnace where indicated, so as not to disturb the present heating furnaces until the new furnace is in successful operation.

The general construction of the furnace proper is shown in Pl. II.

In order to give the furnace sufficient depth for 16-inch jackets of model 1892, that part of the shrinkage pit which is to contain the furnace must be excavated for a depth of 20 feet. This will bring the top of the furnace within 5 feet of the floor line of the shop, and will insure ample hoisting capacity of all traveling cranes.

The body of the furnace consists of a cylinder of sheet steel (⅝-inch or ¾-inch thick) of 8 feet diameter and 35 feet length. The furnace body is made in two sections, for greater convenience. The whole furnace needs to be used only for 16-inch jackets, while for all other parts of 16-inch guns, and for all parts of smaller calibers, either of the two sections D or E (fig. 3) can be used. Section E alone can be used by removing section D and using the cover F on top of the lower section. If section D is to be used, a diaphragm, G, is inserted between the two sections.

This arrangement will be found to be very convenient as regards the various lengths of forgings to be heated, local repairs of the furnace, and economy. It would be a great waste of fuel to heat the whole furnace for a comparatively short forging.

The main conduits for gas and air (H and I) connect the apparatus B with the burners O by means of the vertical distribution mains K, L. The latter are coupled at N for convenience, in case the lower section of the furnace E is to be used, which, however, may rarely be necessary, as the upper section can be easily extended a few feet, by means of a cast-iron cap, for forgings up to 18 feet in length.

Each burner is under separate control by means of valves M, and each vertical distribution main is separately controlled by means of valves P in case it should be desired to obtain a higher degree of heat in one vertical plane than in the other.

The combustion of naphtha gas is nearly perfect, but in order to carry off whatever products of combustion there may be, also to initiate circulation, or flow, the cover F has a hole in its center which can be closed when desired, and the base S as well as the diaphragm G are provided with orifices T for the same purpose. The latter can be connected with the chimney by means of a pipe, U.

The furnace can be made water-tight without difficulty.

The insertion of the burners tangentially was to create a rotary motion of the flame around the part to be heated, but without contact with it. It may not be necessary to surround the forging by means of a screen of boiler plate.

The burners are spirally arranged, and their number may possibly exceed the requirements, which may be considered as a safeguard.

An estimate of the proposed plant is herewith submitted.

Very respectfully, your obedient servant,

ANTHONY VICTORIN,
Constructing Engineer.

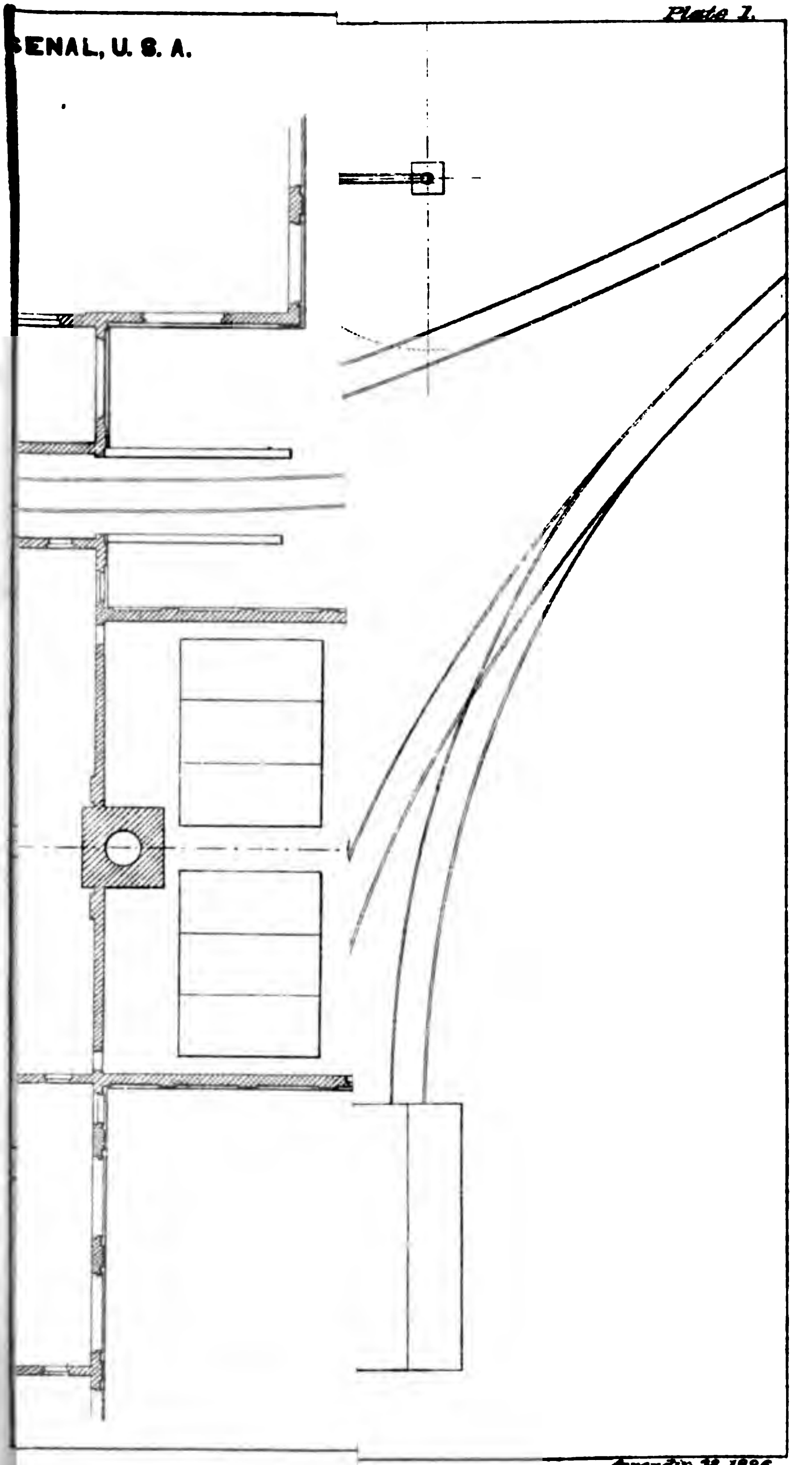
The COMMANDING OFFICER.

Estimated cost of the construction of an oil-gas furnace plant for shrinkage purposes.

Excavations for furnace in shrinkage pit, 80 cubic yards, at $6	$480
Excavations for oil tank, 60 cubic yards, at $2	120
Masonry protection over oil tank	180
Main body (cylinder) of furnace in place, 17,000 pounds, at 5 cents	850
Iron castings of furnace in place, 25,000 pounds, at 3.4 cents	850
Furnace lining	450
Oil-gas machine to furnish 5,000 cubic feet of gas per hour	3,500
Pressure blower for air blast	420
Oil-storage tank, capacity 8,000 gallons	400
Fifty gas blast burners, at $6 (in place)	300
Piping, valves, etc	250
	7,800
Add 10 per cent for contingencies	780
Total	8,580

Plate 1.

SENAL, U. S. A.



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APPENDIX 13.

ANNUAL REPORT OF THE PRINCIPAL OPERATIONS AT THE WATERTOWN ARSENAL.

WATERTOWN ARSENAL, *August 25. 1896.*

The principal operations at the Watertown Arsenal during the fiscal year ending June 30, 1896, have been as follows: In the enlargement and improvement of the gun-carriage plant, the fabrication of gun carriages, shot, shell, implements, and equipments for seacoast fortifications, and for siege and field operations, the improvement and care of buildings, grounds, etc., and the operation of the testing department.

The following machine tools have been purchased, set up, and run during the year:

MACHINES, ETC., PAID FOR DURING THE FISCAL YEAR 1896.

1 20-gross-ton traveling crane	$5,248
1 open-side extension planer, 11 by 8 by 24 feet	11,965
1 radial drilling machine	2,495
1 15-inch shaper	270
1 20-inch upright drill	69
2 32-inch lathes, triple geared	1,980
1 2-inch bolt header with dies	2,714
7 forges with stacks complete	665

It was supposed when I made my last annual report that by the purchase of the foregoing machine tools our plant would, for some time at least, be completed, but the gun-carriage problem is a difficult and progressive one, probably the most perplexing one the Department has to deal with. Since my last report a disappearing carriage for the 12-inch rifle has been designed, and the duty of making this type carriage and several additional ones has been devolved upon this arsenal. It has been found advisable, therefore, to purchase a larger planer than any heretofore contemplated, and a contract has been awarded for a 12 by 10 by 25 foot iron planer. This can only find place in the erecting shop, as the other shops are too narrow for it. Indeed the shops are too narrow for our ordinary work, but being adapted from old shops, all the width possible has been obtained.

Before the work of gun-carriage construction had gotten fully under way, and experience had determined the relative amount of work required from each of the shops to keep the others and the establishment as a whole fully occupied, it was impossible to fix the quantity required of some of them, and we find that the foundry has not the capacity required of it. It should be enlarged if this arsenal is to be depended upon in an emergency.

Congress having appropriated the money for an additional boiler plant and an additional engine, plans have been adopted for taking out the four 50-horsepower boilers and replacing them by a battery of three boilers, 6 feet diameter by 17 feet long each, giving approximately 400 horsepower. This will be ample to run all of the engines, supply the steam heating arrangements, and run a 75-horsepower dynamo. The large cranes in the erecting shop, now operated by hand power, were intended for electric power, and it is contemplated to so equip one of them as soon as the electric plant can be installed.

Experience has shown that the open blacksmith shop is a bad place for the blower and its belts, and it is proposed to remove it to the cellar of the machine shop, where it will not accumulate dirt and where the belts will not be so quickly destroyed. A small engine of about 15 horsepower will be all the power then required for the blacksmith shop, to run the shears and bolt machine, and these will only run at intervals, not amounting to a month in a whole year. This will enable us to dispense with the wire-rope transmission, which now consumes in the neighborhood of 75 horsepower. It will only take about 28 horsepower to run the blower in the cellar. Thus we will effect a saving during 11 months of the year of 35 or more horsepower.

The following list shows the extent and range of the work at this arsenal during the fiscal year:

STATEMENT OF MANUFACTURES.

Barbette carriages, F. P. hydraulic cylinders, 15-inch S. B. gun	6
Barbette carriages for 10-inch B. L. rifle	4
Barbette carriage for 12-inch B. L. rifle	1
Disappearing carriages for 8-inch B. L. rifle	5
Disappearing carriage for 10-inch B. L. rifle	1
Gun-lift carriages for 12-inch B. L. rifle	2

Implements, etc.

Elevating bars for 15-inch barbette carriage	6
Gunners' sleeves, pairs	7
Maneuvering handspikes for 15-inch barbette carriage	12
Pinch bars for 15-inch barbette carriage	6
Muzzle covers and straps for 8-inch converted rifle	6
Pass boxes for 8-inch converted rifle	4
Pinch bars, steel, for 12-inch spring-return mortar carriage	160
Rammers and staves for 8-inch converted rifle	11
Rammer and staff for 8-inch B. L. rifle	1
Rammers and staves for 8-inch B. L. rifles on disappearing carriage	5
Rammer and staff for 10-inch B. L. rifle	1
Rammer and staff for 12-inch B. L. rifle	1
Rammers and staves for 12-inch B. L. mortar	6
Sponges and staves for 12-inch B. L. mortar	7

Projectiles.

Shell, $3\frac{2}{10}$-inch, banded	1,200
Shell, 7-inch mortar, banded	634
Shell, 8-inch cast iron, without sabots, for experiments with high explosives	50
Shell, 12-inch B. L. mortar, banded, 800 pounds	256
Shell, 12-inch B. L. mortar, banded, 1,000 pounds	57
Shot, 10-inch, banded, 575 pounds	56
Shot, 12-inch, banded, 1,000 pounds	440
Shell, 1.65-inch, for rapid-fire gun	1,000

Articles for mechanical maneuvers, etc.

Blocks 12 by 1 by 44 inches	51
Blocks 12 by 2 by 44 inches	40
Blocks 12 by 4 by 44 inches	22
Blocks 12 by 6 by 44 inches	10
Blocks 12 by 12 by 44 inches	54
Blocks 12 by 1 by 46 inches	10
Blocks 12 by 2 by 46 inches	10
Blocks 12 by 2 by 48 inches	14
Blocks 12 by 4 by 48 inches	6
Blocks 12 by 12 by 48 inches	92

Blocks 8 by 1 by 20 inches	10
Blocks 8 by 2 by 20 inches	104
Blocks 8 by 4 by 20 inches	86
Blocks 8 by 8 by 20 inches	86
Pulley blocks for garrison gin, sets	1
Capstan bars with iron bands and rings	4
Hand carts	4
Gun chocks, large	18
Loading cranes for 15-inch barbette carriage	6
Cradle for 8-inch B. L. rifle carriage	1
Gin falls, garrison	5
Gin fall, siege	1
Gin sling, siege	1
Gin handspikes	17
Handspikes with rings	12
Handspikes, maneuvering, 84-inch	48
Model of 8-inch disappearing carriage, one-tenth size	1
Shifting planks	27
Way planks	38
Platform for 4½-inch siege gun	1
Platform for 10-inch siege mortar	1
Platform, segmental, for mounting 8 and 10-inch disappearing carriages	1
Dummy projectiles for 3.2-inch rifle	2
Dummy projectiles for 8-inch converted rifle	8
Roller chocks	20
Half rollers	6
Iron rollers	4
Long rollers	10
Short rollers	27
Securing stakes	148
Shears for Laidley gun-lift, pairs	1
Skids 8 by 8 by 72 inches	44
Skids 8 by 8 by 192 inches	12
Skids 12 by 12 by 192 inches	8
Sling chains	4
Sling chains, large, for gun-lift	2
Sling chains, small, for gun-lift	2
Trace ropes	2
Trestles for mortar	15
Wheel chocks	40

Parts of carriages, etc.

Breech plates, bronze castings, for 8-inch B. L. rifle, model 1888 M_{II}	15
Trays, bronze castings, for 8-inch B. L. rifle, model 1888 M_{II}	15
Bar hooks, for 12-inch spring-return mortar carriages	320
Bolts and nuts for rear guides, Rodman gun, top carriages	4
Bolster, wooden, for 10-inch siege mortar bed	1
Caliper and leveling tools for 8-inch disappearing carriage	2
Caliper and leveling tools for 10-inch disappearing carriage	7
Cast-iron pintle plate, for 12-inch proof carriage	1
Counterweights, lead, for 8-inch disappearing carriage	2
Elevating circle, brass, for 12-inch spring-return mortar carriage	1
Keys and chains, with washers, for axle of 8-inch rifle top carriage	4
Keys for drum for 8-inch converted rifle carriage	2
Keys for wheel for 8-inch converted rifle carriage	2
Name plates, bronze, marked B. I. C., sets	4
Name plates, bronze, marked K. M. C., sets	10
Name plates, bronze, marked P. M. T. C., sets	8
Name plates, bronze, marked W. C. & S. Co., sets	8
Counterweight bottom plate, 8-inch disappearing carriage	1
Parts required for changes in 12-inch gun-lift carriage, sets	3
Parts required in making changes in 12-inch barbette carriage, sets	3
Pintle keys, 15-inch gun carriage	2
Rear eccentric sockets, brass, for 8-inch casemate carriage	4
Rear guide hooks, 15-inch barbette carriage	8
Retraction drums for 8-inch converted rifle carriage	2
Retraction ropes for 8-inch converted rifle carriage	13
Retraction ropes, steel wire, for 15-inch barbette carriage	9
Sight holders and brackets for 8-inch disappearing carriage	2

Stiffening bars, with bolts and pins, for 10-inch disappearing carriage	3
Templet for base plate, 8-inch disappearing carriage	1
Templet for traverse circle, 8-inch disappearing carriage	1
Templets for base plates, 10-inch disappearing carriage	7
Templets for traverse circle, 10-inch disappearing carriage	7
Traversing and elevating direction plates, 10-inch disappearing carriage	24
Trunnion brackets, 15-inch barbette carriage	2
Wrought-iron hood and journal (for crane pulley block) for barbette carriage for 12-inch B. L. rifle	1

Miscellaneous.

Sponge heads, spring leaf, for 8-inch converted rifle	8
Keys and chains, with screw bolts for gin braces	8
Ratchet wheel pawls for gin windlass	4
Ratchet wheel pawls with spiral springs for gin windlass	2
Shoes for garrison gin	6

Inspecting instruments.

Exterior rests for star gauge	2
Punches for use with micrometer for exterior lengths	2

Tools and utensils.

Flatters	5
Hammers	7
Holdfasts, iron	42
Mauls	21
Maul handles	12
Measuring rod, 12 feet long	1
Wrenches, single, 1 inch, 1⅝ inches across flat	6
Wrenches, single, 2 9/16 inches, 4⅝ inches across flat	6
Wrenches, double, ¾ and ⅞ inch, 1¼ and 1 7/16 inches across flat	6
Wrenches, double, 1¼ and 1½ inches, 2 and 2⅜ inches across flat	6

In addition to the foregoing work we have had orders for:

12-inch spring-return mortar carriages for 12-inch steel mortars	6
7-inch siege-mortar carriages and platforms	6
12-inch gun-lift carriages to be adapted to barbette firing	3
15-inch front pintle carriages for 15-inch gun, to be altered to present model	2
10-inch disappearing carriages	5

Work on these carriages has progressed at a moderate rate to keep the arsenal shops employed until the material for the carriages under the new appropriations could be procured. But at this time of writing (August 15) four of the 10-inch disappearing carriages are completed, and the fifth and last one will be completed this month.

The six 12-inch mortar carriages are about three-fourths completed, and will be completed entirely in about two months.

The six 7-inch siege-mortar carriages are about three-fourths completed, and will be completed entire in less than two months.

The two 15-inch altered carriages will be completed in six weeks.

The plans for the necessary alterations to the gun-lift carriages, to adapt them to barbette carriages, are worked out and we hope to have the carriages ready for issue in several months.

All our carriages are not ordered to their destination at once upon completion, and storage room should be provided at this arsenal for them. They should not be exposed to the elements any more than necessary, for carriages of such accuracy of adjustment and many finished surfaces are liable to be rusted and damaged unless well protected. I have therefore estimated for a brick storehouse with a capacity of about 50 gun carriages.

With gun carriages of such complicated and nicely adjusted pieces of mechanism great care has to be taken in their erection, to have all the parts work accurately and smoothly together, and this is particularly true of the disappearing carriages. Equally great care should be taken in their transportation and erection in their emplacements. This latter work should not be intrusted to unskilled labor with extemporized implements. The carriages need be erected properly at first by skilled mechanics familiar with the designs of the carriages, and accustomed to their erection and adjustment. If such men are not available at the forts, the Department should maintain a force at this arsenal or elsewhere for this purpose, and as the gun platforms are liable to settle under the heavy weights imposed upon them, the carriages should be re-leveled from time to time until they have assumed a permanent level. I have thought it proper to mention this subject in this connection, for no matter how good the design of workmanship, defective mounting will not give satisfactory results.

The guns and carriages have outgrown the devices heretofore used in mounting them. A large field for mechanical ingenuity is presented in designing suitable devices. Without them the erection in emplacements of the carriages and the mounting of the guns is a difficult, slow, and unsatisfactory work.

A new and larger office or administration building is an imperative necessity to this arsenal. Whatever delinquencies or delays have occurred in our work here, all, or most of them, may be directly charged to the want of proper office room and office facilities. Officers, clerks, and draftsmen are of necessity crowded in together, each interfering with the work of the others, while valuable drawings and office records are without proper arrangement, such as to be readily accessible. I have submitted an estimate for a new building for this purpose and most earnestly urge its approval.

In the testing department the material tested represents work which has been finished and is in progress at this arsenal and material from other sources, including other arsenals and private establishments engaged in ordnance work.

An enumeration of the classes of material tested shows specimens from tubes and jackets, 10-inch and 12-inch B. L. rifles. In small arms there were tests of steel from barrels and receivers of .30-caliber rifles. In the investigation of the influence of different methods of heating and annealing the rolled rifle barrels, tests were made on the resulting physical properties.

The examination of a .30-caliber barrel, which burst in firing, was made, which included tensile tests and the determination of the hardness of the metal at the eroded surface of the bore.

Cast iron from the arsenal foundry has represented the metal used in 7, 8, 10, and 12 inch shot and shell, also the metal of 12-inch mortar carriage and 10-inch disappearing carriage. Strong metal was shown throughout these tests; exceptionally strong in some instances. The records show a tensile strength of 37,760 pounds per square inch was reached.

Pig irons purchased, and those on which bids for supplies were received, have also been tested.

In bronze, the metal from loading trays for 8, 10, and 12 inch rifles, 8-inch breech plates, and 12-inch mortar trays has been tested. Great strength combined with large ductility has been displayed by these bronze specimens, which were cast of the composition: Copper, 57½; zinc, 42, and tin, ½. One sample gave 60,760 pounds per square inch tensile strength and elongated 35.5 per cent in a length of 2 inches.

Steel samples have been received, representing the material from the

Rock Island Bridge, and samples for the purpose of standardizing other testing machines used in the bridge tests. A large number of chemical analyses have been made of the bridge material.

Hélical springs for 7-inch mortar carriages, 12-inch gun-lift carriage, and 12-inch spring-return mortar carriages have been examined.

Proof stresses have been applied to piston rods and suspension rods for 10-inch disappearing carriages, also for 15-inch carriage, old model. Tensile tests of the metal in the above rods are included in the testing-machine records.

The resistance of banded shot and shell, in bore of guns of different caliber, has been determined. The experiments have included 3.2-inch field guns, 5-inch siege rifle, 7-inch howitzer, and 8 and 10 inch seacoast guns. The observations have included the resistance of the projectiles in a continuous record from the time the bands first engaged the rifling until the muzzle of the gun was reached.

The experiments have included bands of the ordinary service dimensions and those in which the shape and dimensions were modified, for the purpose of ascertaining to what extent the resistance in the bore could be diminished to advantage. The condition of the surface of the bore exerts a considerable influence on the frictional resistance of the band of a projectile, and in these experiments, observations were made with a gun intentionally fouled by firing three rounds with blank cartridges. An enormous increase in frictional resistance was the result, which reached in the gun used, 3.2-inch caliber, 107,100 pounds maximum resistance. A correspondingly high resistance was maintained along the chase of the gun, where the resistance ranged from 40,000 to 50,000 pounds. With bands of modified form and dimensions, the place at which the maximum resistance was attained was different from that with the ordinary type of band.

The rate of speed of the projectiles was necessarily a low one. Taken over such limits as the testing machine permitted, the results showed higher frictional resistance as the speed was kept at the higher limit. In some cases it appeared that a definite maximum resistance might be expected at speeds not far above the experimental velocities. It is not improbable that questions of this kind may be demonstrated in other tests, thereby enabling a closer estimation of the actual resistance encountered during firing than at present possible. So controllable, within limits, appears to be the resistance of the band that firing tests would appear justifiable to further establish what improvements in this direction are feasible through modifications in shape and volume of band.

The initial compression of copper cylinders for use in pressure gauges has been carried on and tarage tables formed for use with the cylinders.

The variance in the indicated powder pressures, as shown by the pressure gauges and as indicated by the Sebert velocimeter, has led to the investigation of the action of the copper cylinders under rapidly applied loads. For the purpose of this investigation, an apparatus has been arranged whereby a rolling weight is made to pass over a lever, under one end of which the copper cylinder is placed to be compressed. Allowing the weight to roll down an incline from different heights enables the work of compression to be done in different intervals of time. In this manner the compression of the copper cylinder is accomplished in an interval of time somewhat nearer the conditions in a gun than can be reached by the testing machine. The minimum time of loading by means of the rolling weight is about one-fifth of a second, in which time the load starts from zero and reaches the maximum, whereupon the rolling weight leaves the lever and the load is then reduced to zero. This method of loading is perhaps as close an approximation to the action in the gun as practicable to attain. It will be readily seen, however, that in the sudden release from the maximum stress the action of the rolling weight is unlike that of the powder pressure, which latter more gradually falls after passing the maximum limit. Still, by reason of this dissimilarity of action, the actual time of the copper cylinder while under the higher stresses is not so different as a comparison of the time in the gun with the time in the experimental apparatus at first sight seems to indicate.

The results with the copper cylinders in the rolling apparatus confirms what has been observed in the testing machine, namely, that the total compression set of the copper cylinder depends much upon the interval of time of loading, the briefer interval in the rolling apparatus results in less total set to the cylinder. The results are most pronounced in examples with uncompressed coppers and with cylinders intended for the small-arms pressure guages, i. e., where large sets are expected, the viscous resistance of the metal retards the total flow which would occur under slower and longer sustained loads. Reasoning directly from these results, lower indicated powder pressures would be expected from uncompressed coppers than from those initially compressed before firing. It is understood that experience at the Proving Ground harmonizes with the above deduction. In so important a matter as the correct determination of powder pressures, it has seemed desirable to give considerable experimental time and attention.

The improvements in the renovation of the testing room and rearrangement of the accessory machine tools has reached an advanced stage toward completion, minor details only remaining to be done. The entire interior of the testing building has been renovated. The main room of the building is occupied by the testing machine, with provision for the standard comparator, now in process of construction, and with further provision for the accommodation of a smaller specimen testing machine, when an appropriation for the latter shall have been made, also provision having been made to receive and set up such microscopic apparatus as future investigations demand. With such apparatus complete, it is believed the testing department would be unsurpassed in facilities for certain classes of investigations.

The former use of the building was for foundry purposes. Every vestige of its foundry appearance has been swept away and in its stead there is presented an interior of attractive appearance, having a natural-wood paneled ceiling, painted walls of a light-colored tint, and hard-wood floor, laid of narrow maple stock. Pipe channels were built below the floor line and practically a new system of hydraulic piping put in, and a depressed line of shafting for driving the testing machine was laid. New valve gears have been constructed, which have been grouped at a convenient place near the head end of the testing machine and in close proximity to the scale and gauge cases. These valves and the shipping lever enable the operator to control all the movements of the machine from one central point; that is, the machine, in its power part, can be run forward or in a reverse direction, the steam pumps for operating the accumulator can be started and stopped, the valves can be set for using either the high or the low pressure rams of the accumulator; all is controlled at one central point.

The hydraulic piping is so arranged that in case of a smaller testing machine being provided the low pressure accumulator ram can be used for the smaller machine, while simultaneously the high-pressure ram is being used for the present 400-ton machine, or any special hydrostatic test can be carried on in lieu of the smaller machine. In order to accomplish these results, it became necessary to construct a special type of safety valve for the accumulator. A simple yet ingenious safety valve was designed and constructed which relieves either ram, automatically changing from one ram to the other as the exigencies of the case require. The accumulator, pump, high-speed steam engine, accessory machine tools, rotating-shaft apparatus, and hot and cold bath tanks for coefficient of expansion determinations have all been placed in the room at the north end of the building. Confining all running machinery and shafting to this north room, which is separated from the main room by a 12-inch brick wall, insures freedom from noise at the testing machine, not an unimportant matter with many tests.

Over this north room and covering the same amount of floor space is located, on the second story, a room assigned for a specimen museum. It is reached from the main room by a handsome hard-wood staircase. The great value of a room of this kind for the preservation of certain tested material and the orderly arrangement of typical specimens is too obvious to require special mention. A number of specimens have been reserved for the museum and more will be added, eventually acquiring a valuable exhibit of material.

The chemical laboratory, located in the second floor of the building adjacent, is reached through the specimen museum. The laboratory consists of a large operating room and three smaller rooms, for a balance room, dark room for photography, and a room for making combustions. These rooms formerly were a part of the carpenter shop and were refitted newly in every detail.

Below the chemical laboratory, on the ground floor of the building, a room has been set off for storage purposes for such apparatus belonging to the testing machine as is not in everyday use, but may at any time be required. This storage room relieves the main testing room of much of the material incidentally required and is conveniently located for the purpose.

The impact machine, which is to be designed and constructed, would appear to require a location on the east side and near the north end of the testing building as a convenient place. The principal features of this machine have not yet been sufficiently considered to present a plan for approval, but it is believed that the apparatus should be of the pendulum type combined with the vertical drop type for low velocities, and provided with a discharging tube for higher velocities, in order to give the machine a range of velocities from zero to the highest attainable, and that the machine should have sufficient capacity as regards dimensions of parts to accommodate full-sized members of machines and parts of field and siege carriages.

The general dimensions would be such as to require a building of considerable size to accommodate it, if entirely covered by a building. It is probable that the working parts could be protected from the weather sufficiently to enable the machine to be erected and used out of doors, at least for a time.

J. W. Reilly,
Major, Ordnance Department, U. S. A., Commanding.

(10222)

APPENDIX 14.

REPORT OF PRINCIPAL OPERATIONS AT THE SANDY HOOK PROVING GROUND DURING THE YEAR ENDED JUNE 30, 1896.

SANDY HOOK PROVING GROUND,
July 31, 1896.

SIR: I have the honor to submit the following report of the principal operations of this post during the fiscal year ended June 30, 1896:

Firings for experimental and proof purposes have been conducted daily during the year whenever the weather and other circumstances would permit. The object of these firings and the nature and character of the work done at the batteries are summarized in the appended tables. Detailed reports of the results of these firings are not included in this report, as they have already been submitted to the Department from time to time by the Ordnance Board and this office.

MACHINE SHOP.

The plant pertaining to the machine shop has been increased by the purchase of one Niles planer, 32 by 32 inches, to plane 10 feet long; one 14-inch-stroke Niles slotter, to slot to center of 60 inches; one Brown & Sharp No. 4 universal milling machine, complete, with change gear, index plates, and tables; one Fitchburg engine lathe, 16-inch swing over ways, bed 8 feet long; and one Pond new pattern 42-inch triple-geared engine lathe, with bed 26 feet long, to turn 7 feet between centers. These machine tools are being put in position as rapidly as other work will permit. They will greatly add to the efficiency of the shop, and the changes and repairs constantly required in connection with experimental firings and tests will hereafter be effected with greater promptness and economy.

WHARF.

The immediate approach to the outer extremity or main portion of the wharf pertaining to this post had so deteriorated by use and long exposure as to become entirely unserviceable.

This approach, 224 feet long by 30 feet 6 inches wide, was originally built on crib work filled with stones. The expense connected with the renewal of these cribs was found to be too great to admit of the restoration of this approach on the original plan. It was therefore decided to remove the cribs and stone until its level was about 6 inches below low-water mark, and on the site so cleared to build the approach on the same plans and using similar specifications to those published in Appendix 29 of the Report of the Chief of Ordnance for 1893. The contract for this work was awarded to John N. Kelly, of 62 Elizabeth street, Brooklyn, for the sum of $4,370. Notwithstanding many unexpected difficulties, due to the large quantities of stone remaining on the site, Mr. Kelly fulfilled all the terms of his contract in a creditable and satisfactory manner, resulting in a substantial and durable improvement to the wharf.

ISSUES OF ORDNANCE TO SEACOAST FORTIFICATIONS.

The following guns, mortars, and carriages of modern construction have been issued from this post for installation in seacoast fortifications built especially for their reception, viz:

To Fort Hamilton, New York Harbor, one 10-inch B. L. rifle, steel.

To Fort Wadsworth, New York Harbor, one 8-inch disappearing carriage; five 8-inch B. L. rifles, steel.

To Willets Point, New York Harbor, two 10-inch B. L. rifles, steel.

To Fort Point, San Francisco, Cal., two 10-inch B. L. rifles, steel; one 10-inch disappearing carriage.

To Sullivans Island, Charleston, S. C., six 12-inch B. L. mortars, cast-iron, steel-hooped; seven spring-return carriages for 12-inch mortars.

RAILWAY.

The railway pertaining to this post, and by which connection is made with the Central Railroad of New Jersey, continues to fulfill all requirements, and proves a source of great convenience and economy in connection with the movement of heavy ordnance.

The road has been improved and strengthened during the year by the removal of old and worn-out ties and rails and replacing them with new ones. All that portion of the road connecting the battery with the line purchased of the Central Railroad has been thoroughly ballasted, using for the purpose the stone taken from the old cribs of the wharf, as described above, and also 80 carloads of slag. The latter proves to be an excellent ballast on sand, and the substantial character and durability of the road so ballasted have been greatly increased. The shipments to and from this post during the year by this route may be summarized as follows:

Total received	pounds..	6,594,527
Total shipped	do....	656,000
Total movement	do....	7,250,527

Number of cars loaded with United States property upon which the Government paid the transportation charges		77
Number of cars loaded with United States property upon which the contractors paid the transportation charges:		
For the Ordnance Department	145	
For the Quartermaster's Department	9	
For the light-house department	3	
For the Life-Saving Service	11	
		168
Total movement		245

Very respectfully, your obedient servant,

FRANK HEATH,
Captain, Ordnance Department, U. S. A., Commanding.

The CHIEF OF ORDNANCE, UNITED STATES ARMY,
Washington, D. C.

(9838—Enc. 13)

SUMMARY TABLES.

TABLE I.—*Siege rifles and howitzers, breech-loading.*

[Rounds given in bold-faced type show that they were fired for two objects. These rounds are not counted in the total for the gun.]

Object of firing.	5-inch rifle.		7-inch howitzer.		Total for object of firing.
	Steel type.	Steel service.	Steel type.	Steel service.	
Test of—					
Maxim smokeless powder	7	6	11	....	24
W.-A. smokeless powder	5	....	....	....	5
French smokeless powder	....	5	....	....	5
Du Pont's sphero-hexagonal powder	....	9	....	....	9
Mounting and to determine pressure curve	....	7	....	....	7
Platform	....	**9**	....	**56**	65
Proof of guns	....	50	....	70	120
Proof to compare Maxim smokeless and Du Pont's sphero-hexagonal powders	....	**8**	....	....	8
Test of carriage service	....	**42**	....	**7**	49
Test to ascertain the maximum velocity obtainable with 125-pound shell within the maximum pressure prescribed for the gun and without overstraining the carriage	....	....	7	....	7
Total for gun	12	77	18	70	....

TABLE II.—*Rapid-fire breech-loading rifles.*

[Rounds given in bold-faced type show that they were fired for two objects. These rounds are not counted in the total for the gun.]

Object of firing.	4-inch Driggs (Navy).	4.7-inch Canét (experimental).	4.7-inch Armstrong (experimental).	Total for object of firing.
Test of gun—				
For endurance	11	....	....	11
For rapidity	24	17	....	41
With dust	5	....	....	5
With excessive charges	5	....	....	5
With defective cartridges	2	....	....	2
Working of breech mechanism	6	36	....	42
With blowbacks	3	....	....	3
After rusting	3	....	....	3
To determine—				
Strain on main bolt during firing	4	....	....	4
Velocities and pressures	....	**36**	....	36
Charge for cordite	....	4	....	4
Accuracy at 1 mile	....	11	....	11
Accuracy at 3,000 yards	....	15	....	15
Rapidity with accuracy at—				
500 yards	....	2	....	2
1,000 yards	....	13	....	13
5,000 yards	....	12	....	12
Prove fixed ammunition exposed to sun	....	4	....	4
To test the mounting and determine the pressure curve	....	....	15	15
To obtain—				
Velocities and pressures	....	....	5	5
Standard pressure	....	....	6	6
Pressure curve with cordite	....	....	**3**	3
Pressure curve with Maxim smokeless powder	....	....	**2**	2
Total for gun	63	114	26	....

TABLE III.—*Breech-loading rifled mortars.*

Object of firing.	3.6-inch steel service.	7-inch steel type.	12-inch steel service.	12-inch cast-iron service.	12.2-inch cast iron experimental.	Total for object of firing.
Test of—						
Mogul springs	8	......	......	......	......	8
Breech mechanism	......	30	......	......	......	30
Accuracy of mortar	......	31	......	......	......	31
Maxim smokeless powder	......	......	3	3	......	6
Du Pont's sphero-hexagonal powder	......	......	8	......	......	8
Pneumatic mortar carriage	......	......	......	45	......	45
Midvale steel shell against 4½-inch plate	......	......	......	6	......	6
To determine whether deformation of base plug or base of shell would occur from shock of discharge.	......	......	......	......	2	2
To determine whether fuse would arm by shock of discharge	6	......	......	......	......	6
To obtain targets	62	......	......	......	......	62
To prove brown prismatic powder	......	15	2	5	......	22
To determine velocities and pressures	......	......	4	......	......	4
To compare Maxim smokeless with Du Pont's sphero-hexagonal powder	......	......	24	......	......	24
Total for mortars	76	76	41	59	2	......

TABLE IV.—*Seacoast guns.*

[Rounds given in bold-faced type show that they were fired for two objects. These rounds are not counted in the total for the gun.]

Object of firing.	Muzzle-loading rifles.		Breech-loading rifles.								Total for object of firing.
	7-inch wrought-iron Ames No. 7.	8-inch cast-iron converted No. 33.	8-inch steel service.	8-inch steel, Bethlehem No. 3.	8-inch steel type.	10-inch wire-wound, Crozier.	10-inch steel service.	10-inch steel type.	12-inch steel service.	12-inch steel type.	
Test of—											
High explosive: "Maximite"	3										3
Maxim smokeless powder	4								4		8
Maxim nitro-gelatine	3										3
Du Pont's sphero-hexagonal		21									21
Non-disappearing barbette carriage: Service			24				11		8		43
Buffington-Crozier disappearing carriages					6		10 17				33
Breech mechanism							10				10
Midvale steel shot 10-inch against 11½-inch plate							5				5
Gun for rapidity				11							11
Gun for accuracy at 3,000 yards				25				11		13	49
Gun for accuracy at 1 mile				8		5		6			19
Gun for endurance				7		39				24	70
8-inch steel shell for United States Projectile Company			2								2
8-inch Midvale steel shell, model 1896, against 4½-inch plate			1								1
Elevation indicator for accuracy						17					17
Gun-lift for rapidity									8	5	8
12-inch carpenter steel shot against 13½-inch plate									4		4
Proof of gun			45				70		40		155
Proof of Du Pont's brown prismatic powder				4		23	19		7	3	56
To determine jump									7		7
For information of Colonel Wilson, Corps of Engineers, U. S. A										1	1
To determine—											
Range				24				31		26	81
Velocities and pressures with charges put up at different dates										4	4
Exhibition before the—											
Board of Ordnance and Fortification						3				1	4
Chief of Ordnance, U. S. A., showing the working of 8-inch Buffington-Crozier disappearing carriage					6						6
Total for gun	10	21	48	79	6	87	85	48	48	77	

TABLE V.—*Field guns.*

Rounds given in bold-faced type show that they were fired for two objects. These rounds are not counted in the total for the gun.]

Object of firing.	Muzzle-loading, 2.5-inch link raw hide.	Breech-loading.					Total for object of firing.
		Maxim 0.303 inch machine.	3.6-inch steel No. 13.	3.2-inch.			
				Gerdom No. 1.	Gerdom No. 2.	Dashiel experiment'l.	
Test of—							
Gun	12	756	......	......	4	3	775
Frankford Arsenal cartridge cases, 3.2-inch	......	......	......	128	......	......	128
W. A. smokeless powder	......	......	......	26	......	......	26
Du Pont's smokeless powder	......	......	......	48	......	3	51
Maxim smokeless powder	......	......	......	17	4	......	21
Maxim ballistite	......	......	......	8	......	......	8
Frankford Arsenal shrapnel, 3.2-inch	......	......	......	40	......	......	40
Peyton's smokeless powder	......	......	......	5	......	......	5
Frankford Arsenal shrapnel, 3.6-inch	......	......	19	......	......	......	19
Exhibition before the Chief of Ordnance, U. S. A.	......	......	......	2	......	......	2
To determine—							
Pressure	......	......	......	11	......	......	11
Charge of powder to give 30,000 pounds of pressure	......	......	......	6	......	......	6
Charge to give standard initial velocity 1,550 feet per second	......	......	55	......	......	......	55
Jump of gun	......	......	98	......	......	......	98
Total for gun	12	756	172	280	4	3	......

TABLE VI.—*Tests in explosion chamber and sand.*

Projectiles and explosives used in experiments.	Number fired.
Fired in explosion chamber:	
3.6-inch cast-iron shell containing 6 ounces dry gun cotton	1
7-inch steel shell containing 6$\frac{5}{16}$ pounds emmensite	1
7-inch steel shell containing 3¾ pounds wet gun cotton	1
Exploded in iron cylinder:	
3.2-inch Frankford Arsenal steel shrapnel	15
3.6-inch Frankford Arsenal steel shrapnel	8
Total	26

RECAPITULATION.

Table I.—Fired from siege rifles and howitzers	177
II.—Fired from rapid-fire guns	203
III.—Fired from mortars	254
IV.—Fired from seacoast guns	509
V.—Fired from field guns	1,227
VI.—Fired in explosion chamber and sand	26
Grand total	2,396

SANDY HOOK PROVING GROUND,
June 30, 1896.

APPENDIX 15.

SUMMARY OF TESTS OF SMOKELESS POWDERS.

SANDY HOOK PROVING GROUND,
August 27, 1896.

SIR: I have the honor to submit the following summary of tests of smokeless powders made at this post during the fiscal year ended June 30, 1896.

During the year firings have been conducted with powders furnished by the American Smokeless Powder Company, the Maxim Powder and Torpedo Company, the California Powder Works (Peyton smokeless powder), the Walsrode Powder Company, and the Messrs. Du Pont. Of foreign powders firings have been made with the French B. N. and English Cordite. The objects of these firings have been to determine the ballistic qualities of the various samples submitted; and also to secure special powders of four different varieties, but possessing substantially the same ballistic qualities, for use in the test of 3.2-inch rifles adapted for metallic ammunition.

Guns of the following calibers have been used in the tests, viz, 6-pounder, 3.2-inch, 4.7-inch, 5-inch, 7-inch howitzer, 12-inch rifle, and 12-inch mortar. In the tables submitted herewith the results are separated according to the calibers of the guns and the objects of firing, viz, the tests of the regular samples submitted and of the special powders for the test of 3.2-inch rifles.

AMERICAN SMOKELESS POWDER.

But few firings have been made with this powder during the year. The tests were made principally for the information of the manufacturers in their efforts to produce a powder suitable for the 8-inch B. L. rifle. No samples for the later rifle have been submitted by this company.

DRIGGS-SCHROEDER 6-POUNDER R. F. GUN.

Date.	Charge.	Projectile.	Velocity.	Pressure.	Remarks.
	Lbs. Oz.	*Pounds.*	*Feet.*	*Pounds.*	
Sept. 23, 1895	1 6	6	1,650	16,560	W.-A. smokeless powder, grade XX, $\frac{1}{12}$ by 10 inch; granulation, 70; 20 per cent nitroglycerin. The grains were solid cylinders. The powder was too slow for this gun.
	1 6	6	1,972	22,946	

3.2-INCH B. L. RIFLE, STEEL, NO. 1.

Date.	Charge.	Projectile.	Velocity.	Pressure.	Remarks.
	Lbs. Oz.	*Pounds.*	*Feet.*	*Pounds.*	
Sept. 23, 1895	1 0	$16\frac{8}{16}$	972	10, 075	W.-A., grade XX, $\frac{7}{16}$ by $\frac{1}{4}$ inch; granulation 600. Number of unburned grains each discharge.
	1 $3\frac{1}{2}$	$16\frac{8}{16}$	1, 173	15, 404	
Oct. 11, 1895	1 0	$16\frac{8}{16}$	1, 014	11, 790	W.-A., grade XX, formula 72; granulation, 869. Grains are cylindrical, about $\frac{1}{2}$ inch long by $\frac{7}{32}$ inch in diameter; are pierced centrally in direction of their length by 1 hole about $\frac{1}{32}$ inch in diameter. Powder is light brown and said to contain 20 per cent nitroglycerin.
	1 4	$16\frac{8}{16}$	1, 228	17, 613	
	1 7	$16\frac{8}{16}$	1, 387	22, 446	
	1 8	$16\frac{8}{16}$	1, 444	23, 883	
Oct. 14, 1895	1 $7\frac{3}{4}$	$16\frac{8}{16}$	1, 411	22, 920	
	1 $7\frac{3}{4}$	$16\frac{8}{16}$	1, 402	22, 100	
	1 $7\frac{3}{4}$	$16\frac{8}{16}$	1, 401	22, 492	
	1 $7\frac{3}{4}$	$16\frac{8}{16}$	1, 400	22, 000	
Oct. 11, 1895	1 6	$16\frac{8}{16}$	1, 531	24, 339	W.-A., grade XXX, formula 76; granulation, 990. Grains are same in size and form as XX, but color a darker brown. This powder is said to contain 30 per cent nitroglycerin.
	1 $4\frac{1}{2}$	$16\frac{8}{16}$	1, 416	20, 185	
Oct. 16, 1895	1 5	$16\frac{8}{16}$	1, 403	20, 354	
	1 5	$16\frac{8}{16}$	1, 412	20, 123	
	1 5	$16\frac{8}{16}$	1, 417	20, 369	

5-INCH B. L. RIFLE, STEEL, NO. 1.

Oct. 8, 1895	5 0	45	1, 256	9, 257 8, 967	W.-A. smokeless; length of grains, $\frac{1}{4}$ inch; diameter, $\frac{7}{16}$ inch; holes $\frac{7}{32}$ inch in diameter.
	6 8	45	1, 835	18, 600 18, 982	
	7 5	45	1, 544	14, 244 14, 689	

WALSRODE SMOKELESS POWDER.

A single sample, for the 3.2-inch rifle, was submitted by the Walsrode Powder Company of New York.

3.2-INCH B. L. RIFLE, STEEL, NO. 1.

Date.	Charge.	Projectile.	Velocity.	Pressure.	Remarks.
	Lbs. Oz.	*Pounds.*	*Feet.*	*Pounds.*	
Sept. 26, 1895	0 12	$16\frac{8}{16}$	1, 213	21, 220	Walsrode cannon, No. 32. The grains are thin square disks, $\frac{7}{32}$ inch long by $\frac{7}{32}$ inch wide by $\frac{1}{40}$ inch thick. Powder is yellow when held up to light, but the grains are coated with graphite, making them appear gray at short distance.
	0 14	$16\frac{8}{16}$	1, 330	25, 815	
	1 00	$16\frac{8}{16}$	1, 462	34, 055	
	0 15	$16\frac{8}{16}$	1, 400	32, 860	
	0 15	$16\frac{8}{16}$	1, 380	28, 380	
	0 15	$16\frac{8}{16}$	1, 404	30, 836	

FRENCH B. N. AND CORDITE.

Firings have been made with these powders from the 5-inch siege gun and 4.7-inch Armstrong rapid-fire gun in connection with the use of the free-recoil carriage, for determining pressure curves. The powders were received at this post, B. N. September 16, 1893; Cordite March 10, 1892, and the results are principally interesting as indicating that smokeless powders can be stored in ordinary powder magazines without deterioration.

5-INCH B. L. RIFLE, STEEL, NO. 11.

Date.	Charge.	Projectile.	Velocity.	Pressure.	Remarks.
	Lbs. Oz.	*Pounds.*	*Feet.*	*Pounds.*	
May 29, 1896	8 0	45	1, 803	22, 480 22, 720	French smokeless B. N., for 4.7-inch Canét gun.
	7 0	45	2, 014	35, 900 35, 600	French smokeless B. N., for 3.2-inch rifle.
June 1, 1896	6 8	$55\frac{3}{16}$	1, 771	33, 764 34, 900	
	6 8	55	1, 781	34, 940 36, 200	

4.7-INCH ARMSTRONG R. F. GUN.

May 25, 1896	5 10	$55\frac{4}{16}$	2, 050	36, 800 38, 422	Cordite.
	5 10	$55\frac{2}{16}$	2. 076	40, 089 40, 022	
	5 10	$55\frac{4}{16}$	2, 079	39, 140 39, 120	

MAXIM SMOKELESS POWDER.

The Maxim Powder and Torpedo Company has been exceedingly active during the year in producing samples of powders adapted to guns of various calibers. In addition to the special powders for the 3.2-inch rifle, firings have been made with most excellent results with the 4.7-inch Armstrong R. F. gun, 5-inch siege rifle, 7-inch siege howitzer, 12-inch mortar, and 12-inch rifle, as shown by the following tables. These results are especially interesting, as, with the exception of the 5-inch rifle, no powders of American manufacture have been tested in these guns. They compare favorably with the best results obtained with foreign powders.

5-INCH B. L. SIEGE RIFLE, STEEL, NO. 11.

Date.	Charge.	Projectile.	Velocity.	Pressure.	Remarks.
	Lbs. Oz.	*Pounds.*	*Feet.*	*Pounds.*	
June 22, 1896	9 4	45	2, 289	32, 280 32, 400	Maxim smokeless, 82^{a}, M. P., 4 J. The powder is cylindrical in shape, 1¼-inches in length and 0.337 inch in diameter. The color is dark brown. Each grain is pierced with 7 holes in the direction of its length. There were no unburned grains.
	9 8	45	2, 330	34, 222 33, 636	
	9 5	50	2, 240	35, 244 34, 980	
	9 5	50	2, 238	35, 680 36, 067	
	9 5	50	2, 232	35, 333 35, 556	

5-INCH B. L. RIFLE, SIEGE, STEEL, NO. 9.

Apr. 4, 1896	9 0	$55\frac{1}{16}$	1, 917	30, 520	Maxim, M. P., 4, for 5-inch gun. The grains of this powder are cylindrical, 1¼ inches long and ¼ inch in diameter. Color, dark brown.
Apr. 8, 1896	9 11	55	2. 121	42, 680	
Apr. 9, 1896	9 3	$55\frac{3}{16}$	2, 178	37, 756	
Apr. 13, 1896	9 2	$55\frac{12}{16}$	1, 920	37. 444	
	9 0	55	2, 163	35, 175	
	9 0	55	2, 152	35, 289	
	9 0	45	2, 261	30, 246	

3.2-INCH B. L. RIFLE, STEEL, GERDOM BREECH MECHANISM, NO. 1.

Date.	Charge.	Projectile.	Velocity.	Pressure.	Remarks.
	Lbs. Oz.	*Pounds.*	*Feet.*	*Pounds.*	
Feb. 14, 1896	1 0	$16\frac{5}{16}$	1,232	15,074	Maxim smokeless, M. P., 3 B., formula, 82ª; granulation, 872. This powder is cylindrical in shape, ½-inch long by ¼-inch in diameter. Each grain is pierced with 7 holes in the direction of its length.
	1 4	$16\frac{9}{16}$	1,531	23,117	
	1 3½	$16\frac{5}{16}$	1,460	23,700	
	1 3½	$16\frac{5}{16}$	1,457	23,580	
	1 3½	$16\frac{5}{16}$	1,458	23,400	
	1 5½	$16\frac{5}{16}$	1,585	27,890	
	1 5¼	$16\frac{5}{16}$	1,571	27,480	

7-INCH B. L. HOWITZER, STEEL, NO. 1.

Aug. 27, 1895	4 12	105	1,102	15,212	Maxim smokeless, M. P., 3 by ⅛ inch, No. 82; granulation, 760. This powder is said to be like the field-gun powder furnished by this company, and in size and appearance is the same. The difference in granulation is probably due to difference in drying or density.
	4 12	105	1,102	15,077	
	4 12	125	1,040	16,000	
	4 12	125	1,044	16,069	
	5 0	125	1,074	17,629	
	5 0	125	1,076	17,629	

12-INCH B. L. CAST-IRON MORTAR, NO. 28.

Jan. 13, 1896	25 0	800	824	14,200 14,140	Maxim, A. 1, formula 82ª. Die, M. P., 6; size, 1 inch.
	35 0	800	1,065	23,420 23,620	
	38 0	800	1,136	26,080 26,560	
	42 0	800	1,154	23,960 24,222	
Jan. 15, 1896	47 0	800	1,258	29,160 30,400	
	47 0	800	1,252	29,618 29,673	

12-INCH B. L. RIFLE, STEEL, NO. 12.

Aug. 27, 1895	130 0	1,004	1,542	15,737 15,282	Maxim smokeless, No. 82; granulation, 12. The grains are made in the form of cylinders, 2⅛ inches long, ⅞-inch in diameter, pierced with 7 canals, each about $\frac{1}{16}$ inch in diameter.
	174 0	1,002	1,847	21,600 22,100	
Sept. 4, 1895	200 0	1,002	2,047	28,709 28,745	
	220 0	1,002	2,204	36,720 35,760	

4.7-INCH ARMSTRONG R. F. GUN.

May 25, 1896	6 13	$55\frac{2}{16}$	2,034	33,360 34,222	Maxim smokeless, M. P., 4.
	6 13	$55\frac{2}{16}$	2,037	33,480 33,782	

5-INCH B. L. RIFLE, STEEL, NO. 1.

Sept. 4, 1895	3 0	45	1,321	10,050 10,200	Maxim smokeless, No. 82, M. P., 3 by ⅛ inch; granulation, 822. This powder is the same as the field-gun powder, except in granulation, which difference is probably due to density or drying.
	4 8	45	1,742	16,650 17,070	
	4 12	45	1,748	19,000 19,350	
	5 0	45	1,821	21,431 21,231	
	5 0	45	1,860	21,354 21,292	
	5 0	45	1,849	21,029 20,946	
	5 0	45	1,810	21,627 21,437	

SPECIAL POWDERS FOR 3.2-INCH B. L. FIELD RIFLES.

For the purpose of securing several kinds of powders, but of the same ballistic qualities, for use in testing certain experimental breech mechanisms for the 3.2-inch field gun, the Department issued the following specifications, dated November 15, 1895. Under these specifications samples were submitted by the California Powder Works, the Messrs. Du Pont, and the Maxim Powder and Torpedo Company. The necessary powders of each variety were obtained, and the tests of the breech mechanisms are now in progress.

SPECIFICATIONS.

These specifications are intended for the procurement of several kinds of smokeless powder for tests in the 3.2-inch field gun, with special reference to a determination of their value as cannon powders, viz:

1. Powder of the same composition as the Peyton smokeless powder for cannon, recently tested by the Department.
2. Powder of the same composition as the Maxim-Schüpphaus smokeless powder for cannon, recently tested by the Department.
3. A plain gun-cotton powder containing no nitroglycerin.
4. Powder having essentially the composition, 75 per cent low grade or nitrocotton, and 25 per cent nitroglycerin.

The field-gun powders must fulfill the service requirements of a powder adapted to the 3.2-inch B. L. field gun with fixed ammunition. They will be used to test experimental breech mechanisms for the 3.2-inch field gun, and at the same time to compare the erosive effects of the powders.

Ballistic qualities.—Each lot must show for acceptance the ballistic qualities stated for the kind of powder as follows: For 3.2-inch field gun, with metallic cartridge case affording 50 cubic inches powder space and projectile weighing 16½ pounds, a muzzle velocity of 1,450 feet per second, with a maximum pressure not less than 27,000 pounds per square inch, nor greater than 30,000 pounds per square inch.

The results obtained with the samples submitted are as follows:

3.2-INCH B. L. RIFLE, STEEL, GERDOM BREECH MECHANISM, NO. 1.

Date.	Charge.		Projectile.	Velocity.	Pressure.	Remarks.
	Lbs.	*Oz.*	*Pounds.*	*Feet.*	*Pounds.*	
Apr. 13, 1896	1	2	16 5/16	1,633	41,900	Maxim smokeless, M. P., 2 B.; granulation, 1,708. The grain of this powder is cylindrical, length ½ inch, diameter ⅛ inch, and is pierced with 7 holes parallel to its length. Color, brown.
	0	15½	16 5/16	1,483	32,640	
Apr. 14, 1896	0	15	16 5/16	1,453	31,690	
	0	14½	16 7/16	1,412	28,720	
	0	14¾	16 5/16	1,425	29,080	
	0	14¾	16 5/16	1,431	30,220	
	0	14¾	16 5/16	1,429	29,400	
	1	3	16 5/16	1,471	23,960	Maxim smokeless, M. P., 2 B.; ballistite. The grains of this powder are cylindrical, length ½ inch, diameter ⅛ inch, and are pierced with 7 holes parallel to its length. The grain is translucent and of a golden-yellow color.
	1	4	16 5/16	1,536	27,200	
Apr. 10, 1896	1	5¼	16 7/16	1,417	27,945	Du Pont's smokeless, No. 63. This powder is a cylindrical grain 7/20 inch in length and 8/20 inch in diameter. It is pierced with 7 holes in the direction of its length. The form of the grain is identical with that of Maxim powder. The color is a dirty cream.

3.2-INCH B. L. RIFLE, STEEL, GERDOM BREECH MECHANISH, NO. 1—Continued.

Date.	Charge.	Projectile.	Velocity.	Pressure.	Remarks.
	Lbs. Oz.	*Pounds.*	*Feet.*	*Pounds.*	
Apr. 10, 1896	1 4½	$16\frac{8}{16}$	1,399	32,620	Du Pont's smokeless, No. 64. This is a square, flat-grained powder having a glazing of graphite. Each side of square is about $\frac{7}{20}$ inch, and the thickness of the grain about $\frac{1}{16}$ inch. Partially burned grains found in bore.
Apr. 17, 1896	1 5½	$16\frac{8}{16}$	1,243	24,900	Du Pont's smokeless, No. 68. This powder differs from No. 64 in that the grains are $\frac{1}{20}$ inch in thickness. Partially burned grains found in bore.
	1 5½	$16\frac{8}{16}$	1,330	29,782	
Apr. 9, 1896	1 1	$16\frac{8}{16}$	1,479	28,927	Peyton smokeless. Each grain of this powder is formed of 2 truncated pyramids placed with their lower parts together. The bases of these pyramids are generally rectangular. The length of the grain is about $\frac{5}{30}$ inch, width $\frac{4}{30}$ inch, height $\frac{5}{30}$ inch. The powder has a glazing of graphite, which can be readily rubbed off, displaying a yellow grain beneath. The smoke is of a light-gray color, which dissipates rapidly and has a disagreeable odor.
	1 0¾	$16\frac{8}{16}$	1,461	28,360	
	1 0¾	$16\frac{8}{16}$	1,459	27,818	
	1 0¾	$16\frac{8}{16}$	1,465	28,280	
Mar. 18, 1896	1 2	$16\frac{8}{16}$	1,215	20,540	Du Pont's smokeless, No. 59. This powder is flat grained, the upper and lower surfaces of the grains being square. The powder has a glazing of graphite. Dimensions of side of square, $\frac{7}{20}$ inch; thickness, $\frac{1}{30}$ inch; granulation, 3,260.
	1 4	$16\frac{8}{16}$	1,330	26,540	
	1 5	$16\frac{8}{16}$	1,438	32,680	
	1 5	$16\frac{8}{16}$	1,391	31,418	Du Pont's smokeless, No. 58. This powder is flat grained, the upper and lower surfaces of the grains being square. The powder has a glazing of graphite. Dimensions of side of square, $\frac{7}{20}$ inch; thickness, $\frac{1}{30}$ inch; granulation, 3,960.
	1 5	$16\frac{8}{16}$	1,372	29,580	
Mar. 8, 1896	1 6	$16\frac{8}{16}$	1,385	32,620	Du Pont's smokeless, No. 60. This powder is flat grained and same dimensions as No. 58. The grains have a smoother finish than those of Nos. 58 and 59. Granulation, 3,500.
Mar. 4, 1896	0 12	$16\frac{8}{16}$	866	7,300	Maxim smokeless, M. P.^{3}, B; granulation, 600. This powder has a composition of 25 per cent nitroglycerin and 75 per cent soluble pyroxyline, with urea added as a neutralizer. The grains are cylindrical. The length of the cylinder is ½ inch and width $\frac{3}{16}$ inch. Each grain is pierced with 7 holes parallel to the elements of the cylinder. The powder is of an amber color and is translucent.
	1 5	$16\frac{8}{16}$	1,277	16,907	
	1 6	$16\frac{8}{16}$	1,333	19,460	
	1 6	$16\frac{8}{16}$	1,338	19,860	

3.2-INCH B. L. RIFLE, STEEL, NO. 1.

Date.	Charge.	Projectile.	Velocity.	Pressure.	Remarks.
	Lbs. Oz.	*Pounds.*	*Feet.*	*Pounds.*	
Feb. 3, 1896	1 2	16$\frac{8}{16}$	1,271	21,370	Du Pont's smokeless, No. 53. The grains of powder are flat and square shaped. The sides of the grain are about $\frac{7}{20}$ inch and $\frac{1}{16}$ inch thick, and have a glazing of graphite. Burning grains projected from gun and partially burned grains found in gun.
	1 3½	16$\frac{8}{16}$	1,364	27,891	
	1 4	16$\frac{8}{16}$	1,407	30,800	
	1 4	16$\frac{8}{16}$	1,412	31,040	
	1 4	16$\frac{8}{16}$	1,399	30,000	
Jan. 31, 1896	1 4½	16$\frac{8}{16}$	1,333	26,640	Du Pont's smokeless, No. 52. The powder is square shaped and flat grained. The sides of the square are about $\frac{7}{20}$ inch and the thickness about $\frac{1}{16}$ inch. The powder has a glazing of graphite, which gives rise to much dust in handling. It is a plain cotton powder. Burning grains thrown from gun and partially burned grains found in bore. The size of partially burned grains diminished as the weight of charge increased.
	1 5	16$\frac{8}{16}$	1,338	27,260	
	1 5½	16$\frac{8}{16}$	1,352	27,855	
	1 7	16$\frac{8}{16}$	1,534	43,780	
	1 6¼	16$\frac{8}{16}$	1,458	37,860	
	1 5¾	16$\frac{8}{16}$	1,408	32,460	
Dec. 18, 1895	1 2	16$\frac{8}{16}$	1,181	18,545	Du Pont's smokeless, No. 47, B. C. The grains of this powder are rectangular disks about 0.39 inch long by 0.36 inch wide by 0.08 inch thick. The color is light buff.
	1 6¾	16$\frac{8}{16}$	1,496	34,527	
Jan. 18, 1896	1 5¾	16$\frac{8}{16}$	1,633	34,467	Du Pont's smokeless, No. 51. The grains of this powder are thin rectangular disks about 0.35 inch long by 0.34 inch wide by about 0.05 inch in thickness. They are translucent and of a dark-brown color.
	1 5	16$\frac{8}{16}$	1,575	31,491	
	1 4¾	16$\frac{8}{16}$	1,551	30,560	
	1 3¾	16$\frac{8}{16}$	1,478	27,560	
	1 3	16$\frac{8}{16}$	1,442	25,855	
	1 3	16$\frac{8}{16}$	1,430	25,120	
Oct. 18, 1895	0 15	16$\frac{8}{16}$	1,306	22,670	Du Pont's smokeless, No. 17, thick. In storage since Apr. 5, 1895.
	0 15	16$\frac{8}{16}$	1,355	27,000	Du Pont's smokeless, No. 19, thick. In storage since Apr. 5, 1895.
	0 15	16$\frac{8}{16}$	1,385	31,260	
	0 15	16$\frac{8}{16}$	1,356	27,745	

3.2-INCH B. L. RIFLE, STEEL, GERDOM BREECH MECHANISM, NO. 2.

June 29, 1896	0 14¼	16$\frac{8}{16}$	1,438	32,855	Maxim, lot 1, 1896, M. P., 2 B ◇L 1◇. Length, ½ inch. Received June 18, 1896.
	0 13½	16$\frac{8}{16}$	1,366	29,618	
June 30, 1896	0 13¼	16$\frac{8}{16}$	1,366	28,280	
	0 13¾	16$\frac{8}{16}$	1,386	29,300	

3.2-INCH B. L. RIFLE, STEEL, GERDOM BREECH MECHANISM, NO. 1.

June 28, 1896	0 14	16$\frac{8}{16}$	1,402	27,260	Maxim smokeless, 82ᵃ, M. P., 2 B ◇L 1◇. The grain of this powder is cylindrical, ½ inch long by $\frac{7}{20}$ inch in diameter, and pierced with 7 holes along parallel to its elements.
	0 14½	16$\frac{8}{16}$	1,427	29,020	
	0 14¼	16$\frac{8}{16}$	1,424	28,964	

3.2-INCH B. L. RIFLE, STEEL, NO. 1.

Oct. 14, 1895	1 5	16$\frac{9}{16}$	1,104	18,100	Du Pont's smokeless, 35–A. The grains of this powder are cylindrical, about ⅝ inch long by $\frac{3}{32}$ inch in diameter. They are pierced in the direction of their length by 7 small holes about $\frac{1}{32}$ inch in diameter. The color may be described as snuff color. Powder is too slow.

3.2 INCH B. L. RIFLE, STEEL, GERDOM BREECH MECHANISM, NO. 1.

Date.	Charge.	Projectile.	Velocity.	Pressure.	Remarks.
	Lbs. Oz.	*Pounds.*	*Feet.*	*Pounds.*	
May 8, 1896	1 4½	$16\frac{8}{16}$	1,418	26,540	Du Pont's smokeless, No. 71. The grains of this powder are cylindrical; length $\frac{7}{16}$ inch. diameter $\frac{5}{16}$ inch, and are pierced with 7 holes parallel to their lengths.
May 21, 1896	1 2	$16\frac{8}{16}$	1,302	19,356	Du Pont's smokeless, No. 1, 1896. The grains of this powder are square disks about 0.057 inch thick and 0.36 inch on a side. They are translucent, and when held up to the light the color is greenish yellow.
	1 5	$16\frac{8}{16}$	1,504	27,400	
	1 5	$16\frac{8}{16}$	1,500	26,180	
June 11, 1896	0 15	$16\frac{8}{16}$	1,315	19,460	Du Pont's ballistite, lot 1 A, 1896. The grains of this powder are thin and approximately square disks from 0.35 to 0.37 inch on a side and from 0.035 to 0.045 inch thick. They are translucent, and when held up to the light the color is a greenish yellow.
	1 1⅛	$16\frac{8}{16}$	1,456	25,300	
	1 1⅛	$16\frac{8}{16}$	1,468	26,560	
	1 4	$16\frac{8}{16}$	1,399	24,244	Du Pont's sample 2 A, 1896. The grains of this powder are cylindrical and pierced with 7 small holes. The length is about ½ inch and diameter about 0.28 inch. Color, grayish yellow. There were no unburned grains.
	1 4¾	$16\frac{8}{16}$	1,461	27,782	
	1 4¾	$16\frac{8}{16}$	1,447	26,927	
June 27, 1896	1 4¾	$16\frac{8}{16}$	1,394	24,480	Du Pont's smokeless, 2 B, 1896. The grain of this powder is cylindrical, 0.49 inch in length and about 0.285 inch in diameter, pierced with 7 holes in the direction of its length. The color is that of a dirty cream. No unburned grains.
	1 5⅛	$16\frac{8}{16}$	1,440	26,460	
	1 5½	$16\frac{8}{16}$	1,443	26,440	

3.2-INCH B. L. RIFLE, NO. 52, CONVERTED TO DASHIEL BREECH MECHANISM.

June 30, 1896	1 5⅝	$16\frac{8}{16}$	1,480	27,600	Du Pont's smokeless, 2 B, 1896; composition "C."
	1 5⅝	$16\frac{8}{16}$	1,500	28,964	
	1 5⅝	$16\frac{8}{16}$	1,493	29,500	

Very respectfully, your obedient servant,

FRANK HEATH,

Captain, Ordnance Department, U. S. A., Commanding.

The CHIEF OF ORDNANCE, UNITED STATES ARMY,

Washington, D. C.

(17054)

APPENDIX 16.

RANGE TABLES FOR 3.6-INCH B. L. FIELD GUN.

SANDY HOOK PROVING GROUND,
October 8, 1895.

SIR: Pursuant to your verbal directions, I have the honor to submit the following report on the firings conducted for the purpose of verifying the range table computed for the 3.6-inch B. L. rifle.

This firing was done with the 3.6-inch B. L. rifle No. 13, and continued whenever practicable from July 20, 1895, until finished, August 28, 1895.

Du Pont's sphero-hexagonal powder, U. F., lot 20, having given very satisfactory results in the 3.2-inch B. L. rifle, it was first selected for trial in this firing. After a number of rounds had been fired with it, it was given up because of the excessive variation in velocity with the same charge. This powder, as well as the U. F., lot 3, thereafter used, was carefully mixed by hand in such a quantity as to be more than enough for the rounds contemplated in this work.

Du Pont's sphero-hexagonal, U. F., lot 3, was then tried, and a charge of 4 pounds 7 ounces, giving a muzzle velocity of 1,547.3 feet per second, was selected. The instrumental velocity was reduced to the muzzle by Ingalls's formula.

All firings to determine the charge were done from the field platform, but all subsequent rounds were fired from the clay bed near the 6-pounder platform. This was done because the conditions there were considered more nearly like those existing in actual service than if the gun were fired from a concrete platform or on the sand.

Before firing for range the angle of jump for each degree up to 10 degrees was determined in the following manner: A screen composed of inch boards was placed at a distance of 100 feet from the muzzle, and the gun fired at it with angles of elevation of 30′, 1°, 2°, etc., up to 10°. The point where the axis of the bore (prolonged) pierced the screen was determined by the bore sights and a marker at the screen. The time of flight, T, to the screen was calculated by Ingalls's formula.

The height of the center of the shot hole above the point where the axis of the bore (prolonged) pierced the screen plus the amount of fall of the projectile in the time, T, gave the increase of the tangent line of the angle of departure over that of the angle of elevation (taking the distance to the screen from the muzzle of the gun when level as the radius). Adding this increase to the tangent line of the angle of elevation by the quadrant, the angle of departure was determined, and subtracting from it the angle of elevation by the quadrant the angle of jump was obtained.

Forty-four rounds in all were fired to determine the jump. The rounds marked R in the firing record were rejected. This was done not only because the jump deduced from them varied greatly from others at the same elevation, but also because they were inconsistent with all others obtained at that time. The mean angle of jump for any elevation was determined by taking the mean increase of the tangent lines of the angle of departure over that of the angle of elevation and computing the jump from this mean. This was done to save the time that would be spent in computing the jump for each round at the same elevation, and taking the mean of these.

It will be seen from the results that the jump varies considerably from round to round. This, however, is to be expected when the nature of the ground is considered. It was found necessary to put a 3-inch plank under the trail to prevent the latter from tearing up the ground.

The jump having been determined, the firing for range was begun and continued whenever possible until finished. To avoid delay the firing was not confined to days when there was no wind, but this effect was left to be corrected by wind formulæ.

The distance of the point of fall of each shot from the muzzle was determined by triangulation, and the distance of the point of fall above or below the muzzle of the gun by leveling. The leveling was done by me and the triangulation by Mr. Tinlin under my direction. Great care had to be exercised in the triangulation because the irregular shore line and the proximity of the woods to the high-water mark made the triangles used much more acute than was desired. The irregularity of the surface of the ground also made the measurement of the base lines difficult. Where the surface was very irregular posts were driven in, their tops leveled with the level, and the measurements made on them. All distances were determined by two independent triangulations and a mean of the results taken. The distances to the origins of the targets fired August 13, 14, and 20, so measured, agreed within 1 yard; the distances to the origin of the target fired August 28, measured by two independent triangulations, agreed within 2 yards. In computing the correction due to the distance of the point of fall below the horizontal plane through the muzzle of the gun it was found sufficiently accurate to estimate the angle of fall from a consideration of the angle of departure and the observed range.

In calculating the correction due to the wind, the formula of Major Muzeau of the French Artillery was used. This formula is given on page 172 of Ingalls's Hand Book of Problems in Direct Fire and is as follows:

$\Delta\chi = W_p\left(T - \frac{Xa\cos\Phi}{V(2a^{-1}}\right)$ in $\Delta\chi$ is the correction due to the wind.

W_p=the component of the velocity of the wind parallel to the plane of fire in feet per second.

T=time of flight.

X=observed range in feet.

V=muzzle velocity.

φ=angle of departure.

$a=\frac{V^2 \sin 2\varphi}{gx}$

g=acceleration of gravity.

The observed time of flight not being considered accurate, the time of flight was calculated by Ingalls's wind formula, as follows:

Using the observed range and the time of flight calculated in still air, determine the value of $v \pm W_p$ by the formula

$$S(v \pm W_p) = \frac{X \pm T\ W_p}{C} + S(V \pm W_p)$$

Having $v \pm W_p$ recalculate the time of flight by the formula

$$T = \frac{C}{\cos\varphi}\left(T(v \pm W_p) - T(V \pm W_p)\right)$$

The value of $\frac{\delta_1}{\delta}$ for each round was determined by dividing the weight in grains of 1 cubic foot of air at 62° F., 30″ barometer, and two-thirds saturation, by the weight in grains of 1 cubic foot of air at the temperature, barometer, and state of saturation that obtained at the instant the gun was fired. These values were taken from the table prepared by Capt. (now Maj. and Paymaster) Charles E. Kilbourne, Signal Corps, published January 1, 1892. The value of $\frac{w}{d^2}$ was taken at 1.5432. The value of *c* was assumed as 0.93 as in the preliminary calculation for the range table. As will be seen by a consideration of the reduced ranges, the value of *c* is not constant, but variable. However, as it only enters into the value of the corrections, it is not thought that the results are much affected thereby.

The value of log C for 62° F., 30″ barometer, and two-thirds saturation, calculated as above, was found to be 0.22186. This is taken as the standard value.

To reduce the ranges (corrected for level of point of fall and for wind) to the ranges under standard conditions of the air, the following method was pursued: From the formula $\sin 2\varphi = A\ C$ it is seen that the product A C is constant for the same angle of departure.

Let A_1 and C_1 be the values under the conditions existing when the gun is fired, and let Ao and Co be the values under the standard conditions of the air. Then $A_1\ C_1 = Ao\ Co$. Dividing the range (corrected for level of point of fall and for wind) by C_1, and entering Table A with the value of z_1 resulting, we take from it the value of A_1. Then $Ao = \frac{A_1\ C_1}{Co}$; and entering Table A again with this value of Ao, we obtain the value of Zo, which multiplied by Co will give the value of Xo, or the range reduced to standard conditions of the air.

This method of reducing the range to standard conditions of the air was reached in a discussion of the subject with Lieutenant Whistler, Fifth Artillery. It is thought to be very satisfactory.

A consideration of the results obtained (see Table 1) shows that the mean reduced range obtained August 13 with a value of $\varphi = 1° 39' 39''$ was 1,134.21 yards. The range corresponding to the same value of φ taken by interpolation from the table is 1,169.64 yards, greater than the former range by 35.43 yards.

The mean reduced range obtained August 14 was 2,167.47 yards, with a value of $\varphi = 3° 35' 17''$. The corresponding range from the table is 2,123.45 yards, less than the former range by 44.02 yards.

The mean reduced range obtained August 20 was 3,183.72 yards, with a value of $\varphi = 6° 04' 32''$. The corresponding range from the table is 3,085.49 yards, less than the former range by 98.23 yards.

The mean reduced range obtained August 28 was 4,352.53 yards, with a value of $\varphi = 9° 12' 41''$. The corresponding range from the table is 4,060.4 yards, less than the former range by 292.13 yards.

The values of *c* corresponding to the reduced ranges above are 1.0995 for the mean reduced range obtained August 13, 0.86724 for that obtained August 14, 0.84 for the mean reduced range obtained August 20, 1895, and 0.7577 for that obtained August 28, 1895.

The circumstances of fire, the observed results, and the different corrections and reductions compiled in the form of a table are herewith submitted.

Very respectfully, your obedient servant,

COLDEN L'H. RUGGLES,
First Lieutenant, Ordnance Department, U. S. A.

The COMMANDING OFFICER, SANDY HOOK PROVING GROUND.

(8425)

Date.	No. of fire.	Powder.		Projectile.		Angle of elevation.	Jump.	Angle of departure.	Thermometer.		Humidity.	Barometer.	Log. C.	Velocity of wind per hour.	Direction of wind.	Observed range.	Depth of point of fall below muzzle.	Correction of range due to depth of point of fall below muzzle.	Accelerating component of wind.	Correction due to wind.	Initial velocity.	Correction to reduce range to standard initial velocity (1,550 F. S.)	Correction to reduce range to standard condition of atmosphere (62° F., 30″ Bar.) (to ⅔ saturation).	Range reduced to standard conditions.
		Kind.	Weight.	Kind.	Weight.				Dry.	Wet.														
			Lbs. Oz.		Lbs.				°	°				Miles.	Right and rear:	Feet.	Feet.	Feet.	Ft. sec.	Feet.			Feet.	Yards.
1895. Aug. 13	157	U. F., lot 3.	4 7	Lot 683.	20	1° 22′	17′ 39″	1° 39′ 39″	86	69	42	30.02	0.24215	12	10°....	3,569.61	5.249	—150.31	17.332	— 12.28	1,547.3 feet per second.	+9.5 feet.	— 25.56	1,130.32
	158		4 7		20				86	70	45	30.02	0.24232	12	10°....	3,610.44	5.523	—158.16	17.332	— 12.28			— 27.44	1,140.69
	159		4 7		20				85	71	50	30.02	0.24172	12	15°....	3,575.28	5.412	—154.98	17.003	— 12.05			— 25.21	1,130.85
	160		4 7		20				85	71	50	30.02	0.24172	12	10°....	3,604.80	5.349	—153.18	17.332	— 12.28			— 26.86	1,140.66
															Rear:									
	161		4 7		20				85	69	44	30.02	0.24148	12	0°....	3,606.51	5.541	—158.68	17.600	— 12.47			— 26.37	1,139.50
	162		4 7		20				85	69	44	30.02	0.24148	14	0°....	3,611.70	5.443	—155.87	20.533	— 14.55			— 26.37	1,141.47
	163		4 7		20				85	70	47	30.02	0.24155	14	0°....	3,582.15	4.840	—138.60	20.533	— 14.55			— 26.20	1,137.48
	164		4 7		20				85	70	47	30.02	0.24155	13	0°....	3,557.07	6.250	—178.98	19.067	— 13.51			— 22.89	1,117.06
	165		4 7		20				84	69	46	30.02	0.24060	12	0°....	3,562.59	6.069	—173.80	17.600	— 12.47			— 22.44	1,121.13
	166		4 7		20				84	69	46	30.02	0.24060	12	0°....	3,614.52	5.467	—156.56	17.600	— 12.47			— 25.90	1,143.03
															Left and rear:									
Aug. 14	168	U. F., lot 3.	4 7	Lot 683.	20	3° 18′	17′ 17″	3° 35′ 17″	78	68	60	30.17	0.23372	5	30°....	6,512.59	0.691	— 7.85	6.35	— 14.15	1,547.3 f. s.	+15.39 feet.	— 48.68	2,152.43
	169		4 7		20				79	69	60	30.17	0.23466	6	75°....	6,566.34	0.845	— 9.59	2.28	— 5.11			— 52.58	2,171.48
	170		4 7		20				79	69	60	30.17	0.23466	6	75°....	6,507.42	1.030	— 11.69	2.28	— 5.11			— 52.58	2,171.14
	171		4 7		20				80	69	57	30.17	0.23543	6	75°....	6,542.54	0.894	— 10.15	2.28	— 5.10			— 55.63	2,162.35
	172		4 7		20				80	69	57	30.16	0.23558	4	75°....	6,592.88	0.772	— 8.77	1.52	— 3.42			— 56.30	2,179.93
															Right and rear:									
Aug. 20	177	U. F., lot 3.	4 7	Lot 683.	20	5° 50′	14′ 32″	6° 4′ 32″	80	65	44	30.10	0.23576	18	30°....	9,898.21	1.705	— 10.76	22.86	—100.17	1,547.3 feet per second.	+17.67 feet.	—100 25	3,234.90
	178		4 7		20				80	65	44	30.10	0.23576	19	85°....	9,730.16	1.843	— 11.64	22.83	—100.01			— 95.28	3,180.30
	179		4 7		20				79	64	43	30.10	0.23482	18	40°....	9,786.92	1.897	— 11.98	20.22	— 88.61			— 91.01	3,204.33
	180		4 7		20				79	64	43	30.10	0.23482	18	42°....	9,778.91	2.673	— 16.88	19.62	— 85.96			— 91.01	3,200.91
	181		4 7		20				78	64	46	30.09	0.23420	18	25°....	9,700.86	2.264	— 14.29	23.93	—103.84			— 83.40	3,172.33
	182		4 7		20				78	64	46	30.09	0.23420	16	30°....	9,758.43	2.607	— 16.46	20.32	— 89.04			— 84.33	3,195.42
	183		4 7		20				78	64	46	30.09	0.23420	15	40°....	9,655.41	1.916	— 12.08	16.85	— 78.14			— 83.25	3,168.20
	184		4 7		20				77	63	45	30.09	0.23327	16	40°....	9,421.23	3.260 above.	+ 20.62	17.98	— 76.85			— 75 87	3,102.27
	185		4 7		20				77	63	45	30.09	0.23327	16	30°....	9,697.24	1.328	— 8.38	20.32	— 88.20			— 78.97	3,179.79
	186		4 7		20				77	63	45	30.09	0.23327	15	30°....	9,757.56	2.506	— 15.82	19.05	— 83.48			— 79.74	3,198.73

																Right and front:									
Aug. 28	189	U. F., lot 3.	4	7	Lot 683.	20	9° 00′	12′ 41″	9° 12′ 41″	87	71	45	30.09	0.24222	12	30°....	13,187.20	3.149	− 12.205	15.242	+116.48	1,547.3 feet per second.	+20.00 feet.	−212.48	4,349.67
	190		4	7		20				86	71	48	30.09	0.24149	13	20°....	13,176.64	3.943	− 15.282	17.917	+136.92			−205.08	4,371.07
	191		4	7		20				86	71	48	30.09	0.24149	12	20°....	13,158.66	3.916	− 15.178	17.917	+136.92			−205.08	4,365.11
	192		4	7		20				85	70	47	30.09	0.24054	13	20°....	13,199.43	2.863	− 11.097	17.917	+136.92			−195.07	4,383.39
	193		4	7		20				85	70	47	30.09	0.24054	13	10°....	13,027.83	2.416	− 9.365	18.777	+143.50			−195.07	4,328.97
	194		4	7		20				83	70	52	30.09	0.23899	10	15°....	13,025.48	2.125	− 8.237	14.167	+108.27			−178.97	4,322.18
	195		4	7		20				83	70	52	30.09	0.23899	13	Front: 0..	13,104.68	3.279	− 12.709	19.067	+145.71			−178.97	4,359.57
																Right and front:									
	196		4	7		20				83	70	52	30.09	0.23899	13	10°....	13,101.24	3.034	− 11.760	18.777	+143.50			−178.97	4,358.00
	197		4	7		20				82	73	65	30.08	0.23896	13	15°....	13,102.14	2.671	− 10.353	18.417	+140.74			−178.53	4,358.00
	198		4	7		20				82	75	72	30.08	0.23939	13	10°....	13,014.39	1.843	− 7.144	18.777	+143.50			−182.88	4,329.29

RANGE TABLES.

OFFICE OF THE CHIEF OF ORDNANCE, U. S. A.,
Washington, D. C., February 1, 1896.

The following are the corrected range tables based upon the preceding report of firings, except that as regards the weight of powder charge for which the standard weight of sphero-hexagonal U. R. powder (4 pounds 3 ounces) required to give a muzzle velocity of 1,550 feet per second with projectile of 20 pounds, is taken.

In order to make the ranges of the corrected range tables approximate closely to the measured ranges, a series of values are assigned to the coefficient of reduction, *c*, instead of using a constant value for this factor. These values decrease with the range. The corresponding values of the ballistic coefficient, C, are estimated for an atmosphere two-thirds saturated with moisture.

For the common shell, the values of *c* are, for given ranges, as follows: One thousand yards, c=1.09; 2,000 yards, c=0.94; 3,000 yards, c=0.84; 4,000 yards, c=0.78. For the shrapnel, these values are multiplied by the ratio $\frac{1.03}{0.93}$, which represents the increase in the coefficient of shrapnel over shell, as determined from the tests of similar projectiles of 3.2-inch caliber (see appendix 22, Report of the Chief of Ordnance, U. S. A., 1894).

RANGE TABLE FOR 3.6-INCH B. L. RIFLE, STEEL, WITH COMMON SHELL.

Shell, filled and fused	pounds	20
Bursting charge, mortar powder	do	.993
Length of shell	inches	11.64
Powder charge, sphero-hexagonal, U. R	pounds	4.1875
Muzzle velocity	feet per second	1,550

This range table is based upon firings made at the Sandy Hook Proving Ground in 1895 (8425).

The angle of jump varies from about 18 minutes at 1 degree to 12 minutes at 10 degrees elevation. Its value has been deducted in the column of "Elevation."

Each division of the horizontal scale of the 3.6-inch breech sights now in use equals one three-hundred-and-forty-fifth part of the distance between sights, thus giving a correction of about 0.9 of a foot for deflection for each 100 yards of the range. This variation is tabulated under the heading "Deflection for one division of the horizontal scale."

The scale of yards for shell, on the front face of the sight, is marked for each 100 yards of range and is read from an index line on the slide.

3.6-inch B. L. rifle.

[Shell, 20 pounds. Muzzle velocity, 1,550 feet per second.]

Range.	Elevation.		Variations.		Time of flight.	Fall.			Terminal velocity.
			Range, 1 minute elevation.	Deflection, 1 division, hor. scale.		Angle.		Inclination, 1 yard in—	
Yards.	°	'	*Yards.*	*Feet.*	*Sec.*	°	'	*Yards.*	*Ft. sec.*
500	0	20	11	4.4	1.03	0	41	81	1,315
600	0	29	11	5.2	1.27	0	53	63	1,272
700	0	38	10	6.1	1.52	1	06	52	1,235
800	0	48	10	7.0	1.77	1	19	44	1,203
900	0	58	10	7.8	2.02	1	32	38	1,175
1,000	1	08	10	8.7	2.27	1	45	33	1,150
1,100	1	18	10	9.6	2.53	2	00	29	1,127
1,200	1	29	9	10.5	2.79	2	15	26	1,106
1,300	1	40	9	11.3	3.05	2	30	23	1,087
1,400	1	51	9	12.2	3.32	2	45	21	1,070
1,500	2	02	9	13.0	3.59	3	00	19	1,055
1,600	2	13	8	13.9	3.87	3	17	17	1,041
1,700	2	25	8	14.8	4.15	3	34	16	1,028
1,800	2	37	8	15.7	4.43	3	51	15	1,016
1,900	2	49	8	16.6	4.71	4	08	14	1,005
2,000	3	02	7	17.4	4.99	4	26	13	995
2,100	3	15	7	18.3	5.28	4	45	12	985
2,200	3	28	7	19.2	5.57	5	04	11	976
2,300	3	41	7	20.0	5.87	5	23	10	967
2,400	3	54	7	20.9	6.17	5	43	9	959
2,500	4	07	7	21.8	6.47	6	03	9	951
2,600	4	21	7	22.6	6.78	6	24	8	943
2,700	4	35	7	23.5	7.09	6	45	8	935
2,800	4	49	7	24.4	7.40	7	07	7	928
2,900	5	04	7	25.3	7.71	7	29	7	921
3,000	5	19	7	26.1	8.03	7	51	6	914
3,100	5	34	7	27.0	8.35	8	14	6	907
3,200	5	49	7	27.9	8.68	8	38	6	900
3,300	6	05	6	28.7	9.01	9	02	6	893
3,400	6	21	6	29.6	9.34	9	26	6	887
3,500	6	37	6	30.5	9.67	9	50	5	881
3,600	6	53	6	31.4	10.01	10	16	5	875
3,700	7	10	6	32.2	10.35	10	42	5	869
3,800	7	27	6	33.1	10.69	11	08	5	863
3,900	7	44	6	34.0	11.04	11	34	5	857
4,000	8	02	6	34.8	11.39	13	01	5	851
4,100	8	20	6	35.7	11.75	12	29	5	845
4,200	8	38	6	36.6	12.11	12	58	5	839
4,300	8	56	5	37.5	12.47	13	27	5	833
4,400	9	15	5	38.3	12.84	13	56	5	828
4,500	9	35	5	39.2	13.21	14	25	4	823

RANGE TABLE FOR 3.6-INCH B. L. RIFLE, STEEL, WITH SHRAPNEL.

Shrapnel, filled and fused	pounds..	20.0
Bursting charge, rifle powder	ounces..	4.0
Length of shrapnel	inches..	11.24
Powder charge, sphero-hexagonal, U. R	pounds..	4.1875
Muzzle velocity	feet per second..	1,550

This range table is based upon firings made at the Sandy Hook Proving Ground in 1895 (8425).

The angle of jump varies from about 18 minutes at 1 degree to 12 minutes at 10 degrees elevation. Its value has been deducted in the column of "Elevation."

The scale of yards for shrapnel, on the rear face of the breech sight, left side, is arranged with diagonal lines to be read in the same manner as the degree scale. Each diagonal embraces 250 yards of range, and there are five divisions on the upper edge of the slide by which this space is subdivided so that intervals of 50 yards in range are read directly from the scale.

The tabular numbers of the column "Differs from shell" indicate the necessary increase of elevation in passing from shell to shrapnel firing to attain the same range.

FUSE SCALE.

The fuse scale is based upon the time of burning in flight. Each unit (representing 1 second) is divided into six parts. The "units" are numbered and marked by through holes in the fuse cover.

The tabular numbers of the column "Divisions" indicate the point of the time train to be cut for each range. These numbers correspond to a time of flight which is generally less than the tabulated time of flight by an amount required to cause the shrapnel to burst at a point within a distance of 75 yards short of the target.

The bursting interval may be regulated by lengthening or shortening the cut of the fuse scale—using the tabular numbers of the column "Variation in range, 1 subdivision."

A common rule for height of burst is that the height above ground should not exceed 1 foot for each 100 yards of range (5 feet at 500, 10 feet at 1,000, 20 feet at 2,000 yards, etc.), or should, for every range, be below a prolonged line inclined 10 minutes above the line joining gun and foot of target.

An observed height of burst may be regulated by the tabular numbers of the column "Change in height of burst for 1 minute elevation."

Example, illustrated by tabular numbers: Suppose the gun to be ranged to strike at the foot of the target at 2,000 yards. The bursting interval for the prescribed cut of 5 units and 0 sixth is then 0.1 of a second, or ($\frac{1}{10} \times 58 \div \frac{1}{6}$) 35 yards short of the target. By the "inclination of fall" (1 yard in 12) the height of burst would be ($35 \times 3 \div 12$) about 9 feet. If it were desired to increase this height to 15 feet, for example, the 6 feet additional would be obtained by giving 3 minutes (of arc) more elevation to the gun, since, at this range, 1 minute corresponds to a change of 1.7 feet in the height of burst.

3.6-inch B. L. rifle.

[Shrapnel, 20 pounds. Muzzle velocity, 1,550 feet per second.]

Range.	Elevation.			Variations.		Time of flight.	Fuse scale.			Change in height of burst, 1 minute elevation.	Fall.			Terminal velocity.
	Angle.		Differs from shell.	Range, 1 minute elevation.	Deflection, 1 division hor. scale.		Divisions.		Variation in range, 1 sub-division.		Angle.		Inclination, 1 yard in—	
Yards.	°	′	*Min.*	*Yards.*	*Feet.*	*Secs.*	*Units.*	*Sixths.*	*Yards.*	*Feet.*	°	′	*Yards.*	*Ft. sec.*
500	0	21	1	10	4.4	1.05	0	5	70	0.4	0	44	79	1,293
600	0	31	2	10	5.2	1.30	1	1	67		0	57	62	1,250
700	0	41	3	10	6.1	1.55	1	2	67		1	10	50	1,212
800	0	51	3	10	7.0	1.80	1	4	67		1	23	43	1,178
900	1	01	3	10	7.8	2.06	1	5	64		1	37	37	1,148
1,000	1	11	3	9	8.7	2.32	2	1	64	0.9	1	51	32	1,121
1,100	1	22	4	9	9.6	2.58	2	3	64		2	06	28	1,097
1,200	1	33	5	9	10.5	2.85	2	4	62		2	21	25	1,076
1,300	1	45	5	9	11.3	3.12	3	0	62		2	37	22	1,058
1,400	1	56	5	8	12.2	3.39	3	1	62		2	53	20	1,042
1,500	2	08	6	8	13.0	3.67	3	3	60	1.3	3	10	18	1,027
1,600	2	20	7	8	13.9	3.95	3	5	60		3	27	16	1,013
1,700	2	32	7	8	14.8	4.23	4	1	60		3	45	15	1,000
1,800	2	44	7	8	15.7	4.52	4	2	58		4	03	14	988
1,900	2	57	8	8	16.6	4.81	4	4	58		4	22	13	977
2,000	3	10	9	8	17.4	5.10	5	0	58	1.7	4	41	12	967
2,100	3	24	9	8	18.3	5.40	5	2	56		5	01	11	957
2,200	3	37	9	7	19.2	5.70	5	3	56		5	21	10	947
2,300	3	51	10	7	20.0	6.00	5	5	56		5	41	10	938
2,400	4	05	11	7	20.9	6.31	6	1	54		6	02	9	929
2,500	4	19	12	7	21.8	6.62	6	3	54	2.2	6	24	9	920
2,600	4	34	13	7	22.6	6.93	6	5	54		6	46	8	912
2,700	4	49	14	7	23.5	7.25	7	1	52		7	09	8	904
2,800	5	05	15	7	24.4	7.57	7	3	52		7	32	8	896
2,900	5	20	16	7	25.3	7.90	7	5	51		7	55	7	888
3,000	5	35	16	6	26.1	8.23	8	1	51	2.6	8	19	7	881
3,100	5	51	17	6	27.0	8.56	8	2	51		8	43	7	874
3,200	6	07	18	6	27.9	8.90	8	4	49		9	08	6	867
3,300	6	23	19	6	28.7	9.24	9	1	49		9	34	6	860
3,400	6	41	20	6	29.6	9.58	9	3	49		10	00	6	853
3,500	6	58	21	6	30.5	9.93	9	5	48	3.0	10	27	6	847
3,600	7	16	23	6	31.4	10.28	10	1	48		10	54	5	841
3,700	7	34	24	6	32.2	10.64	10	3	46		11	22	5	835
3,800	7	52	25	6	33.1	11.00	10	5	46		11	50	5	829
3,900	8	10	26	6	34.0	11.36	11	1	46		12	19	5	823
4,000	8	29	27	5	34.8	11.73	11	4	45	3.5	12	49	5	817
4,100	8	48	28	5	35.7	12.10	12	0	45		13	19	4	811
4,200	9	08	30	5	36.6	12.48	12	2	44		13	50	4	805
4,300	9	28	32	5	37.5	12.86	12	4	44		14	22	4	799
4,400	9	48	33	5	38.3	13.25	13	1	43		14	55	4	794
4,500	10	09	34	5	39.2	13.64	13	3	43	3.9	15	28	4	789

Record of firing with 3.6-inch B. L. rifle, steel, No. 13, Watervliet

[Object of firing, to determine charge to give

Date.	No. of fire.	Powder.			Projectile.		Instrumental velocity 125 feet from muzzle.	Pressure per square inch of bore.	Recoil.		Wind, strength, and direction.
		Kind.	Weight.		Kind.	Weight.					
1895.			*Lbs.*	*Oz.*		*Pounds.*	*Feet.*	*Pounds.*	*Ft.*	*In.*	
July 20	46	Du Pont's sphero-hexagonal, U. F., lot 20.	4	6	Shell, lot 683.	20	1,473 1,478	5, 33,140	15	9	Wind from right and front, 45°, 8 miles an hour; barometer, 30.19; thermometer, 68°; humidity, 57.
July 20	47		4	8		20	1,572 1,575	25, 33,708	18	0	
July 20	48		4	7		20	1,553 1,558	5, 33,692	19	0	
July 20	49		4	6		20	1,550 1,552	25, 33,100	18	0	
July 20	50		4	4		20	1,528 1,532	5, 32,677	16	3	
July 20	51		4	4½		20	1,531 1,533	25, 32,782	16	0	
July 20	52		4	5		20	1,528 1,530	25, 33,060	15	0	
July 20	53		4	5		20	1,540 1,542	....	15	0	
July 20	54		4	5		20	1,539 1,542	....	18	0	
July 20	55		4	5		20	1,552 1,555	....	16	0	
July 20	56		4	5		20	1,544 1,545	....	18	0	
July 20	57		4	5		20	1,532 1,535	....	14	0	
July 22	......		3	0		....	....	....	....		Wind from right and rear, 20°, 12 miles an hour; barometer, 30.06; thermometer, 89°; humidity, 61.
July 22	58		4	4½		20	1,507 1,508	....	15	0	
July 22	59		4	4½		20	1,511 1,508	....	13	0	
July 22	60		4	4½		20	1,507 1,509	....	14	0	
July 22	61		4	4½		20	1,513 1,515	....	14	0	
July 22	62		4	4½		20	1,522 1,525	....	15	0	
July 22	63		4	4¾		20	1,521 1,521	....	15	0	
July 22	64		4	4¾		20	1,516 1,522	....	15	0	
July 22	65		4	4¾		20	1,526 1,531	....	15	0	
July 22	66		4	4¾		20	1,531 1,536	....	15	0	
July 22	67		4	4¾		20	1,534 1,539	....	15	0	
July 22	68		4	4¾		20	1,524 1,527	....	15	0	
July 22	69		4	4¾		20	1,529 1,530	....	15	0	
July 22	70		4	4¾		20	1,533 1,533	....	15	0	
July 22	71		4	4¾		20	1,530 1,524	....	15	0	
July 22	72		4	4¾		20	1,532 1,528	....	15	0	
July 23	73		3	0	Shell, lot 351.	20	....	....	....		Wind from right and rear, 25°, 7 miles an hour; barometer, 30.14; thermometer, 83°; humidity, 55.
July 23	74		3	0		20					
July 23	75		4	5	Shell, lot 683.	20	1,537 1,537	....	14	0	
July 23	76		4	5		20	1,530 1,536	....	16	0	
July 23	77		4	5		20	1,536 1,542	....	16	6	
July 23	78		4	5		20	1,539 1,540	....	14	0	
July 23	79		4	5		20	1,545 1,545	....	15	0	
July 23	80		4	4¾		20	1,531 1,534	....	16	0	
July 23	81		4	4¾		20	1,528 1,533	....	16	0	
July 23	82		4	4¾		20	1,541 1,543	....	16	0	
July 23	83		4	4¾		20	1,542 1,535	....	16	0	
July 23	84		4	4¾		20	1,540 1,540	....	16	0	

Arsenal, at Sandy Hook Proving Ground, from July 20 to 24, 1895.

standard initial velocity (1,550 feet per second)].

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
	Gun mounted on Buffington steel field carriage, No. 13, bow-spring brakes. Cannon friction primers, model 1887, Frankford Arsenal, September, 1890. Fired into field butt No. 1. 32.000 coppers of 1890.
Warming charge	
2 primers failed	
Warming charges	
2 primers failed	
First primer failed	

Record of firing with 3.6-inch B. L. rifle, steel, No. 13, Watervliet

[Object of firing, to determine charge to give

Date.	No. of fire.	Powder.		Projectile.		Instrumental velocity 125 feet from muzzle.	Pressure per square inch of bore.	Recoil.	Wind, strength, and direction.
		Kind.	Weight.	Kind.	Weight.				
1895.			*Lbs. Oz.*		*Pounds.*	*Feet.*	*Pounds.*	*Ft. In.*	
A.M.									
July 24	85	Du Pont's sphero-hexagonal, U. F., lot 3	4 6	Shell, lot 351.	20	....	....	....	Wind from left and front, 30°; 9 miles an hour; barometer, 30.17; thermometer, 77°; humidity, 52.
July 24	86		4 6		20				
July 24	87		4 8	Shell, lot 683.	20	1,540 1,536	....	....	
July 24	88		4 8		20	1,528 1,529	....	....	
July 24	89		4 8		20	1,543 1,544	....	....	
July 24	90		4 8		20	1,546 1,548	....	....	
July 24	91		4 7½		20	1,540 1,546	....	....	
July 24	92		4 7½		20	1,535 1,540	....	....	
July 24	93		4 7½		20	Lost. 1,540	....	....	
P.M.									
July 24	94		4 8½	Shell, lot 351.	20	....	....	....	
July 24	95		4 8½		20				
July 24	96		4 7	Shell, lot 683.	20	1,530 1,531	....	....	
July 24	97		4 7		20	1,531 1,533	....	....	
July 24	98		4 7		20	1,530 1,531	....	....	
July 24	99		4 7		20	....	10, 30,243 25, 32,108	17 0	
July 24	100		4 7		20	....	10, 31,200 25, 32,709	16 0	

Arsenal, at Sandy Hook Proving Ground, from July 20 to 24, 1895—Continued.

standard initial velocity (1,550 feet per second)].

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Warming charges	Gun mounted on Buffington steel field carriage, No. 13, bow-spring brakes. Cannon friction primers, model 1887, Frankford Arsenal, September, 1890. Fired into field butt No. 1. 32,000 coppers of 1890.
First primer failed	
Warming charges	
First primer failed	

Record of firing with 3.6-inch B. L. rifle, steel, No. 13, Watervliet Arsenal,

[Object, to

Date.	No. of fire.	Powder.		Projectile.		Height of the center of the shot hole above the point where the axis of the bore prolonged pierced the screen.	Drop of the shot while passing from the muzzle to the screen due to the action of gravity.	Elevation.	Angle of departure.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.					
1895.			*Lbs. Oz.*		*Pounds.*	*Inches.*		° ′		*Pounds.*
July 30	101	Du Pont's sphero-hexagonal, U. F., lot 3.	4 8	Lot 351.	20	....	....	......	....	....
July 30	102		4 8		20	....	....	......	....	....
July 30	103		4 7	Shell, lot 683.	20	R, 0 11/16	0.83⅛ inch.	0 30	....	....
July 30	104		4 7		20	5 5/8		0 30	....	....
July 30	105		4 7		20	5		0 30	....	....
July 30	106		4 7		20	5		0 30	....	....
July 30	107		4 7		20	5 1/8		1 00	....	....
Aug. 2	108		4 7	Lot 351.	20	....		......	....	....
Aug. 2	109		4 7		20	....		......	....	....
Aug. 2	110		4 7	Shell, lot 683.	20	5 5/8		1 00	....	....
Aug. 2	111		4 7		20	5 1/8		2 00	....	....
Aug. 2	112		4 7		20	R, 3 15/16		2 00	....	....
Aug. 2	113		4 7		20	4 7/8		2 00	....	....
Aug. 2	114		4 7		20	5 3/16		2 00	....	....
Aug. 2	115		4 7		20	5		1 00	....	....
Aug. 2	116		4 7		20	5 5/8		1 00	....	....
Aug. 2	117		4 7		20	5 7/8		2 00	....	....
Aug. 2	118		4 7		20	4 5/8		2 00	....	....
Aug. 2	119		4 7		20	R, 3 5/8		3 00	....	....
Aug. 3	120		4 7		20	....		......	....	....
Aug. 3	121		4 7		20	5		3 00	....	....
Aug. 3	122		4 7		20	5 7/16		3 00	....	....
Aug. 5	123		4 7	Lot 351	20	....		......	....	....
Aug. 5	124		4 7	Lot 683	20	5 1/8		4 00	....	....
Aug. 5	125		4 7		20	5 9/16		4 00	....	....
Aug. 6	126		4 7	Lot 351	20	....		......	....	....
Aug. 6	127		4 7	Shell, lot 683.	20	R, 3 1/4		5 00	....	....
Aug. 6	128		4 7		20	4		5 10	....	....
Aug. 6	129		4 7		20	3 3/4		5 00	....	....
Aug. 6	130		4 7		20	4 5/8		6 00	....	....
Aug. 6	131		4 7		20	3 9/16		5 00	....	....
Aug. 6	132		4 7		20	3 15/16		6 00	....	....
Aug. 6	133		4 7		20	4 1/16		7 00	....	....
Aug. 6	134		4 7		20	3 1/8		7 00	....	....
Aug. 6	135		4 7		20	R, 2 3/8		8 00	....	....
Aug. 6	136		4 7		20	2 13/16		8 00	....	....
Aug. 6	137		4 7		20	3 1/4		9 00	....	....
Aug. 6	138		4 7		20	3 1/8		9 00	....	....
Aug. 6	139		4 7		20	3 9/16		10 00	....	....
Aug. 10	140		4 7	Re-banded	20	....		......	....	....
Aug. 10	141		4 7	Lot 683.	20	R, 1 13/16		10 00	....	....
Aug. 10	142		4 7		20	2 11/16		10 00	....	....
Aug. 10	143		4 7		20	2 5/16		15 00	....	....
Aug. 10	144		4 7		20	3 5/16		15 00	....	....
Aug. 12	145		4 7	Lot 351	20	....		......	....	....
Aug. 12	146		4 7	Lot 683.	20	4		8 00	....	....
Aug. 12	147		4 7		20	4 7/8		6 00	....	....
Aug. 12	148		4 7		20	5		4 00	....	....
Aug. 12	149		4 7		20	4 5/8		2 00	....	....
Aug. 12	150		4 7	Lot 351	20	....		2 00	....	....
Aug. 12	151		4 7	Shell, lot 683.	20	5 1/8		2 00	....	....
Aug. 12	152		4 7		20	4 1/4		10 00	....	....
Aug. 12	153		4 7		20	4 3/4		9 00	....	....
Aug. 12	154		4 7		20	3 11/16		8 00	....	....
Aug. 13	155		4 7		20	*Time of flight, seconds.* 3		1 22	....	....
Aug. 13	156		4 7		20	*Jump.* 4 7/8		8 00	1° 39′ 39″	

at Sandy Hook Proving Ground, from July 30 to August 28, 1895.

determine jump.]

Recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Ft.	*In.*			
6	0	Wind from rear, 0°, 20 miles an hour; barometer, 29.88; thermometer, 77°; humidity, 78.	Warming charges............	After round 100, gun fired from platform made of clay and ashes. Fired at 1-inch screen placed 100 feet from muzzle. The angle of jump for any elevation given in this record is the mean of all the rounds of that elevation fired to determine the jump, except in cases of rounds marked R, which rounds were rejected because of their great variation from all the others fired at the same time and under the same circumstances, which variation gave rise to the suspicion that there was something abnormal about them. Round 104: First primer failed. A 3-inch plank placed under trail. Round 106: Two 1-inch boards under trail, making trail level with platform. Round 108: Warming charge; 2 primers failed. Round 109: Warming charge. Round 120, warming charge. Round 123, warming charge. Round 126, warming charge. Round 128, primer hung fire. Round 129. primer hung fire. Round 135, primer hung fire. Round 140, warming charge. Round 150, warming charge.
6	0			
10	6		Mean angle of jump for 30′ elevation, 17′ 4″.	
9	0			
11	0			
11	0			
11	0		Mean angle of jump for 1° elevation, 17′ 57″.	
10	0	Wind from rear and right, 30°, 10 miles an hour; barometer, 30.10; thermometer, 75°; humidity, 51.		
10	0			
10	0			
10	0			
10	0			
10	0		Mean angle of jump for 2° elevation, 17′ 7″.	
10	0			
11	0			
10	0			
10	0			
10	0			
10	0			
7	6	Wind from right and front, 45°, 10 miles an hour; barometer 30.15; thermometer, 80°; humidity, 71.	Mean angle of jump for 3° elevation, 17′ 17″.	
9	4			
•8	4			
....		Wind from right and rear, 30°, 10 miles an hour; barometer, 30.08; thermometer, 80°; humidity, 72.		
....			Mean angle of jump for 4° elevation, 17′ 17″.	
....				
8	0	Wind from right and front, 20°; 15 miles an hour; barometer, 30.14; thermometer, 78°; humidity, 71.		
9	0			
7	6			
7	6		Mean angle of jump for 5° elevation, 13′ 5″.	
7	6			
8	0			
6	0			
7	0			
6	0		Mean angle of jump for 6° elevation, 14′ 49″.	
9	0			
8	0			
8	0			
8	0		Mean angle of jump for 7° elevation, 12′ 29″.	
8	0			
8	0	....		
8	0	....		
9	6	....	Mean angle of jump for 8° elevation, 13′ 08″.	
8	6	....		
7	0	....		
....		....	Warming charge.............	
7	0	....	Mean angle of jump for 10° elevation, 12′ 41″.	
7	6	....		
8	0	....		
10	0	....	Mean angle of jump for 10° elevation, 12′ 2″.	
10	0	....		
10	0	....		
8	0	....		
9	0	....	Mean angle of jump for 15° elevation, 9′ 34″.	
8	0	....		
10	0	....		
9	0	....		

Record of firing with 3.6-inch B. L. rifle, steel, No. 13, Watervliet Arsenal, at

[Object, to

Date.	No. of fire.	Powder.			Projectile.		Height of the center of the shot hole above the point where the axis of the bore prolonged pierced the screen.	Drop of the shot while passing from the muzzle to the screen due to the action of gravity.	Elevation.		Angle of departure.	Pressure per square inch of bore.
		Kind.	Weight.		Kind.	Weight.						
1895.			Lbs.	Oz.		Pounds.	Time of flight, seconds.		°	'		Pounds.
Aug. 13	157	Du Pont's sphero-hexagonal, U. F., lot 3.	4	7	Shell, lot 683.	20	3	0.83⅛ inch.	1	22	1° 39′ 39″	....
Aug. 13	158		4	7		20	3		1	22		....
Aug. 13	159		4	7		20	3		1	22		....
Aug. 13	160		4	7		20	3		1	22		....
Aug. 13	161		4	7		20	3		1	22		....
Aug. 13	162		4	7		20	....		1	22		....
Aug. 13	163		4	7		20	3		1	22		....
Aug. 13	164		4	7		20	....		1	22		....
Aug. 13	165		4	7		20	3		1	22		....
Aug. 13	166		4	7		20	3		1	22		....
Aug. 14	167		4	7		20	....	....	3	18	3° 35′ 17″	....
Aug. 14	168		4	7		20	5¼	....	3	18		....
Aug. 14	169		4	7		20	5¼	....	3	18		....
Aug. 14	170		4	7		20	5¼	....	3	18		....
Aug. 14	171		4	7		20	6	....	3	18		....
Aug. 14	172		4	7		20	6	....	3	18		....
Aug. 20	173		4	7		20	15	....	5	50		....
Aug. 20	174		4	7		20	9	....	5	50		....
Aug. 20	175		4	7		20	....	....	5	50	6° 4′ 32″	....
Aug. 20	176		4	7		20	9½	....	5	50		....
Aug. 20	177		4	7		20	10	....	5	50		....
Aug. 20	178		4	7		20	10¼	....	5	50		....
Aug. 20	179		4	7		20	9½	....	5	50		....
Aug. 20	180		4	7		20	9½	....	5	50		....
Aug. 20	181		4	7		20	9¾	....	5	50		....
Aug. 20	182		4	7		20	9½	....	5	50		....
Aug. 20	183		4	7		20	9½	....	5	50		....
Aug. 20	184		4	7		20	10	....	5	50		....
Aug. 20	185		4	7		20	9½	....	5	50		....
Aug. 20	186		4	7		20	10	....	5	50		....
Aug. 28	187		4	7		20	13	....	9	00	9° 12′ 41″	....
Aug. 28	188		4	7		20	13	....	9	00		....
Aug. 28	189		4	7		20	13	....	9	00		....
Aug. 28	190		4	7		20	13	....	9	00		....
Aug. 28	191		4	7		20	13	....	9	00		....
Aug. 28	192		4	7		20	13	....	9	00		....
Aug. 28	193		4	7		20	13	....	9	00		....
Aug. 28	194		4	7		20	13	....	9	00		....
Aug. 28	195		4	7		20	13	....	9	00		....
Aug. 28	196		4	7		20	13	....	9	00		....
Aug. 28	197		4	7		20	13	....	9	00		....
Aug. 28	198		4	7		20	13	....	9	00		....

Sandy Hook Proving Ground, from July 30 to August 28, 1895—Continued.

determine jump.]

Recoil.		Wind.			Barometer.	Thermometer.	Humidity.	Range.	Deviation (right).	Range reduced to standard conditions.	General remarks.
		Direction.	Miles per hour.	Degrees.							
Ft.	*In.*					°		*Yards.*	*Yards.*	*Yards.*	
10	0	Right and rear.	12	10	30.02	86	42	1,189.87	0.278	1,130.32	
10	0		12	10	30.02	86	45	1,203.48	0.000	1,140.69	
10	0		12	15	30.02	85	50	1,191.76	*a* 0.236	1,130.85	
10	0		12	10	30.02	85	50	1,201.60	0.167	1,140.66	
10	0	Rear.	12	0	30.02	85	44	1,202.17	0.792	1,139.56	
10	0		14	0	30.02	85	44	1,203.90	0.611	1,141.47	
10	0		14	0	30.02	85	47	1,194.05	*a* 0.333	1,137.43	
10	0		13	0	30.02	85	47	1,185.69	1.194	1,117.06	
10	0		12	0	30.02	84	46	1,187.53	0.278	1,121.13	
10	0		12	0	30.02	84	46	1,204.84	0.278	1,143.03	
			Mean reduced range							1,134.21	
			Corresponding value of "c"							1.0995	
10	0	Left and rear.	..	..	......	..	..	....	....	....	
10	0		5	30	30.17	78	60	2,170.86	2.208	2,152.43	
10	0		6	75	30.17	79	60	2,188.78	4.194	2,171.48	
10	0		6	75	30.17	79	60	2,189.14	4.167	2,171.14	
10	0		6	75	30.17	80	57	2,180.85	4.368	2,162.35	
10	0		4	75	30.16	80	57	2,197.63	2.833	2,179.93	
10	0		..	..	......	..	..	....	....	....	
9	0		..	..	......	..	..	....	....	....	
			Mean reduced range							2,167.47	
			Corresponding value of "c"							0.86724	
9	0	Right and rear.	..	..	......	..	..	....	....	....	The deviation of the points of fall to the left of the line of fire in this target is accounted for by the wind blowing from the right and rear.
10	0		..	..	......	..	..	....	....	....	
10	0		18	30	30.10	80	44	3,290.40	*a* 8.889	3,234.90	
10	0		19	35	30.10	80	44	3,243.39	*a* 16.021	3,180.30	
10	0		18	40	30.10	79	43	3,262.31	*a* 8.924	3,204.33	
10	0		18	42	30.10	79	43	3,259.64	*a* 4.799	3,200.91	
10	0		18	25	30.09	78	46	3,233.62	*a* 7.458	3,172.33	
10	0		16	30	30.09	78	46	3,252.81	*a* 3.549	3,195.42	
9	6		15	40	30.09	78	46	3,218.47	*a* 2.625	3,168.20	
9	6		16	40	30.09	77	45	3,140.41	*a* 2.917	3,102.27	
10	0		16	30	30.09	77	45	3,232.41	*a* 6.333	3,179.79	
10	0		15	30	30.09	77	45	3,252.52	*a* 5.000	3,198.73	
			Mean reduced range							3,183.72	
			Corresponding value of "c"							0.84	
....		Right and front.	..	..	......	..	..	....	....	....	Sighting shots.
....			..	..	......	..	..	....	....	....	
....			12	30	30.09	87	45	4,379.07	19.424	4,349.67	
....			13	20	30.09	86	48	4,392.21	16.431	4,371.07	
....			12	20	30.09	86	48	4,386.22	16.108	4,365.11	
....			13	20	30.09	85	47	4,399.81	20.816	4,383.39	
....			13	10	30.09	85	47	4,342.61	15.889	4,328.97	
....			10	15	30.09	83	52	4,341.83	17.194	4,322.18	Firing conducted by Lieut. C. L'H. Ruggles, Ordnance Department, assistant proof officer.
....		Front.	13	0	30.09	83	52	4,368.23	14.250	4,359.57	
....		Right and front.	13	10	30.09	83	52	4,367.08	17.694	4,358.00	
....			13	15	30.08	82	65	4,367.38	18.507	4,358.00	Frank Heath, Captain, Ordnance Department, U. S. A., commanding.
....			13	10	30.08	82	72	4,338.13	17.222	4,329.29	
			Mean reduced range							4,352,53	Colden L'H. Ruggles, Lieutenant, Ordnance Department, U. S. A.
			Corresponding value of "c"							0.7577	

a Left.

APPENDIX 17.

TESTS OF CHARCOAL AND SMOKELESS POWDERS AT BENICIA ARSENAL, FROM SEPTEMBER 1, 1895, TO AUGUST 31, 1896.

A beginning has been made toward carrying out the plan of a new proving ground mentioned in my last report, by mounting a 12-inch mortar at the site selected and erecting the necessary screens for the measurement of velocities. The mortar carriage received from the Sandy Hook Proving Ground is of the barbette type and permits horizontal firing only. To simplify its installment and to facilitate the operations of loading as well, the front bolsters and pintle plate, the rear forks and traverse wheels, and the two middle props were removed from the carriage. No part was left projecting below the chassis cheeks. The chassis cheeks are bolted directly to two longitudinal timbers of a platform constructed wholly of 12 by 12 pine timbers in two layers. The lower layer consists of about fifteen 8-foot timbers laid transversely, the upper layer of three 25-foot timbers laid longitudinally. Bolts passing through both layers and the lower chassis rails hold the platform together and the carriage to the platform. The platform is given an inclination of 4° upward to the rear, its upper surface being flush with the ground. This brings the axis of the trunnions not more than 4 feet above the ground and enables the piece to be loaded with very little trouble. About 6 tons of iron are placed on the forward end of the platform to prevent the shock of recoil lifting it from the ground. A vertical wall was cut in the opposite hillside, which is of soft rock, to fire into. Thus far the shot have been retained in the hill.

Very little progress has been made in the development of smokeless powders on this coast since my last report. The Giant Powder Company have purchased and set up a Boulengé chronograph, and have now a well-equipped testing plant for small-arm powders. The United States Smokeless Powder Company have experimented during the year with powder for the 3.2-inch field gun without satisfactory results. There being on hand here no field gun adapted to the use of metallic cartridges the chamber capacity of the piece used was diminished by the insertion of a cylindrical block of hard wood between the powder charge and the breechblock. The pressure gauge was at first put in the breechblock. In this position of the gauge, removed about 5 inches from the charge, the pressures recorded were abnormally high, due, probably, to the energy acquired by the gases of explosion. The gauge was afterwards placed in the forward end of the wooden block against the charge with more satisfactory results. The results of the firings under these conditions can only be regarded as approximately correct, since the pressures to which the wooden blocks were subjected had the effect of considerably compressing them, reducing their diameters as much as three-quarters of an inch.

But one new variety of smokeless powder for small arms has been tested during the year. This is called "Italian smokeless powder," and is made by Messrs. Parlato & Salamone, of San Jose, Cal., manufacturers and dealers in fireworks.

CHARCOAL POWDERS.

With the exception of a lot of 2,500 pounds of saluting powder for the 10-inch muzzle-loading smoothbore, the tests of charcoal powders have been confined to the powders intended for use in the 12-inch breech-loading rifle and the 12-inch breech-loading mortar, cast iron. The firings with the rifle, and part of those with the mortar, were done at Fort Winfield Scott, San Francisco Harbor. The remaining firings with the mortar were done at this arsenal. On account of the lack of room on the parapet of the 12-inch rifle and of the high winds that usually prevail in that locality, difficulty was experienced in satisfactorily arranging and holding the velocity screens in front of the gun, until the California Powder Works put up, at their own expense, a set of rigid iron frames in which the screens slide, and are held fixed in their proper positions. In the mortar firings at Fort Winfield Scott the velocities were calculated from ranges measured by triangulation. The deduced muzzle velocities were necessarily inaccurate, due to the errors of observation, the uncalculated effects of the winds, and whatever inaccuracies may exist in the formulas employed for the deduction. These objections do not apply to the firings made at this arsenal.

The results of the tests of charcoal powders are set forth below. The powders are all made by the California Powder Works of Santa Cruz, Cal., who still have uncompleted contracts for powders for the 10-inch and 12-inch B. L. rifles.

Brown prismatic powder for 12-inch B. L. rifle,

[Requirements: Contract of June 24, 1895—Charge, 455 pounds; projectile, 1,000 pounds; muzzle velocity, 2,000 feet; pressure, 37,000 pounds Contract of December 2, 1895—Charge, 490 pounds; projectile, 1,000 pounds; muzzle velocity, 2,025 feet; pressure, 38,000 pounds.

Date of contract.	Date of tests.	Charge.	Velocity.	Mean pressure.	Remarks.
		Pounds.	*Feet.*	*Pounds.*	
June 24, 1895.	Sept. 20, 1895	400	....	33,958	
		425	....	46,000	
Do.......	Oct. 3, 1895	410	1,912	40,125	
		415	....	Less than 30,000	Powder prisms 2¼ inches long.
		425	....	Less than 30,000	Do.
Do.......	Nov. 19, 1895	435	1,562	Less than 25,000	
Do.......	Dec. 9, 1895	435	1,957	40,000	
Do.......	Jan. 14, 1896	435	1,800	32,335	
Do.......	Feb. 26, 1896	435	1,840	34,292	Lot 1.
		455	1,881	35,970	Do.
		435	1,820	36,550	Lot 2.
Do.......	Apr. 3, 1896	455	1,963	41,250	
Do.......	June 8, 1896	455	2,000	35,510	
Do.......	July 15, 1896	455	1,998	37,400	Accepted.

The tests set forth in the above table, with the exception of the last one, are tests of samples of powder only. The table exhibits the efforts of the manufacturers in the development of the powder, this being the first powder made by them for the 12-inch rifle.

Brown prismatic powder for 12-inch B. L. mortar.

[Requirements: Contract December 2, 1895—Charge, 75 pounds; projectile, 800 pounds; muzzle velocity, 1,020 feet; pressure, 27,500 pounds.]

Date of test.	Charge.	Range.	Corresponding velocity.	Pressure.	Remarks.
	Pounds.	*Yards.*	*Feet.*	*Pounds.*	
Apr. 3, 1896.	70			25,000	
Do	75	8,809	1,004	28,975	Range approximate.
Do	75	8,905	1,011	29,050	Do.
June 26, 1896.	73			27,750	Accepted.
Do	72		1,073	27,700	Do.

The firing of April 3 was done at Fort Winfield Scott, that of June 26 at this arsenal.

Black-molded powder for 12-inch B. L. mortar.

[Requirements: Contract December 2, 1895—Charge, 40 pounds; projectile, 800 pounds; muzzle velocity, 710 feet; pressure, 22,500 pounds.]

Date of test.	Charge.	Range.	Corresponding velocity.	Pressure.
	Pounds.	*Yards.*	*Feet.*	*Pounds.*
Apr. 3, 1896	40	4,635	702	Less than 15,000.
Do	40	4,590	693	Do.
June 26, 1896	40			Do.
Do	40		729	Do.
July 24, 1896	19		432	Less than 5,000.

The firing of April 3 was done at Fort Winfield Scott, the firings of June 26 and July 24 at this arsenal.

SMOKELESS POWDERS.

UNITED STATES SMOKELESS POWDER.

Firings with this powder have been confined to the 3.2-inch B. L. rifle. The grains are round and sifted through sieves of the sizes shown.

Date of test.	Size of powder.	Charge.		Projectile.		Velocity.	Pressure.	Remarks.
	Meshes.	*Lbs.*	*Oz.*	*Lbs.*	*Oz.*	*Feet.*	*Pounds.*	
Sept. 13, 1895.	4 to 5	1	12	13	8	1,627	37,480	Means of two rounds. Powder not all burned in gun.
Do	3 to 4	1	12	13	8	1,635	38. 200	
Do	2 to 3	1	12	13	8	1,633	36,175	
Sept. 24, 1895	5 to 6	1	13	13	8	1,640	37,450	Mean of 3 rounds.
Do	6 to 7	1	14	13	8	1,696	42,200	
July 10, 1896.	2 to 3	1	2	16	8	1,283	33,200	Chamber capacity about 55 cubic inches.
Do	5 to 6	1	1	16	8	1,230	28,260	
July 28, 1896.	5 to 6	1	2	16	8	1,224	27,800	Chamber capacity about 50 cubic inches.
Do	2 to 3	1	2	16	8	1,243	35,000	

GIANT SMOKELESS POWDER.

The following table exhibits the results of tests, in the .30-caliber rifle, of samples submitted by the Giant Powder Company. The powders designated M 23 and J 10 were reported upon last year. The table includes additional tests of these powders after storage for six months and one year. The suffix X indicates that the powder was stored in boxes from which the air was not excluded; the suffix C, that the powder was stored in sealed bottles.

Powder.	Charge.	Velocity.	Pressure.	Date of test.
	Grains.	*Feet.*	*Pounds.*	
M 23	36	2,006	38,167	May 23, 1895
M 23 X	36	1,979	36.580	Nov. 26, 1895
Do	36	2,058	38,700	July 2, 1896
M 23 C	36	1,976	36,125	Nov. 26, 1895
Do	36	2,035	39,075	July 2, 1896
J 10	39	1,957	37,200	June 10, 1895
J 10 X	39	1,877	35,100	Nov. 26, 1895
Do	39	2,004	37.000	July 2, 1896
J 10 C	39	1,943	35,050	Nov. 26, 1895
Do	39	2,012	35,800	July 2, 1896
N 27	44½	2,094	36,833	Nov. 30, 1895

ITALIAN SMOKELESS POWDER.

This is a white powder made by hand in small round grains, which are not too hard to be crushed between the fingers. When ignited it burns quickly with a bright white flame. Fired, it produces little smoke and leaves but a slight residue in the bore. The makers claim that the powder is not affected by heat or cold. The following tests were made in the .30-caliber rifle:

Date and designation of powder.	Charge.	Velocity.	Pressure.	Remarks.
	Grains.	*Feet.*	*Pounds.*	
Aug. 8, 1896	30	1,486	36,000	
Aug. 17, 1896:				
A	30	1,512	36,000	Grains very irregular.
B	28	1,406	37,600	Grains smaller and more regular.
C	27	1,378	38,000	Grains still smaller.

Respectfully submitted.

ORMOND M. LISSAK,
Lieutenant, Ordnance Department.

BENICIA ARSENAL, CAL., *August 31, 1896.*

(17188)

APPENDIX 18.

ANNUAL REPORT OF THE INSPECTOR OF POWDER.

OFFICE OF INSPECTOR OF POWDER, U. S. A.,
Wilmington, Del., August 31, 1896.

SIR: I have the honor to submit, in compliance with your instructions, the report of this office for the fiscal year ending June 30, 1896.

PROVING GROUND.

The installation of the proving ground attached to this office now comprises the following pieces, together with carriages, chronographs, pressure gauges, etc., necessary for their use:

1 8-inch B. L. rifle, model 1888.
1 3.6-inch field gun, model 1891.
1 3.2-inch field gun, model 1890.
1 .30-caliber magazine rifle, model 1892.

To which may be added for practical use the following belonging to the Du Pont Company:

1 6-inch naval B. L. rifle.
1 .30-caliber pressure barrel.
1 .45-caliber Springfield rifle.
1 .45-caliber Springfield rifle pressure barrel.

Nearly all the tests of samples required for information can be made with these pieces, and they have all, except the 3.6-inch field gun, been in frequent use during the year for that purpose, 56 rounds being fired from the 8-inch gun, mostly with brown powder, and 100 from the 3.2-inch gun, all with smokeless powder.

CHARCOAL POWDERS.

Preparation of cartridges.—During the past year the issue of ammunition to the service for use in the new seacoast armament has begun, and regulations or instructions have been prepared for putting up the cartridges. The following are the essential requirements: For guns, the charge must occupy practically the whole length of the chamber in order to avoid the occurrence of abnormal excessive pressures arising from wave action; hence the cross section of the cartridge must be adjusted to the charge employed. In certain cases peculiar forms have to be given to the cartridge in order to allow free entrance into the chamber. And for convenience in handling, the charges are divided into two portions for the 8 and 10 inch guns and into four for the 12-inch guns. For the 12-inch mortars with short chambers the precaution of maintaining the length of the reduced charges by a reduction of the cross section is not necessary.

In order to determine whether the regular arrangement of the prisms of brown powder exercises any influence on the combustion, certain firings with the 12-inch steel mortar at Sandy Hook Proving Ground were conducted with the charges alternately built up in the usual manner for this kind of powder and poured loose into a bag, as with sphero-hexagonal powder. The results obtained were as follows:

Charge.	Arrangement.	Pressure per square inch.	Muzzle velocity.
Pounds.		*Pounds.*	*Ft. sec.*
55	Packed	13,200	795
55	Loose	11,900	786
78	Packed	20,700	975
78	Loose	20,500	977

Seven black prisms, about 10 ounces, were used as the igniter in the packed cartridges and 2½ ounces of black rifle powder in the loose ones. The results indicated a slight superiority of pressure and velocity for packed cartridges, but it is so slight as to be largely ascribable to the difference in the igniters, and warrants the admission that whenever the size of the charge will allow it (less than 80 pounds for the steel and 58 pounds for the cast-iron mortar) the cartridges need not be packed for these pieces. Indeed, when the conditions in the chamber are considered, together with evidence of the slight effect of variation of the mode of ignition, as set forth in the last annual report of this office, it would seem highly improbable that the packing of the cartridge would have any considerable effect on its combustion; and this view is supported by some of my own results here with the 8-inch steel rifle. But for the guns the amount of the charge will generally require that it be packed.

Variation of charcoal powder with the season.—All charcoal powders vary in quickness with the season, being quicker in summer and slower in winter than their normal condition. This is particularly true of brown powder, which has been found to change materially even when hermetically sealed, and when no actual deterioration is going on. The change in pressure with the same charge is sometimes as great as 10 per cent between winter and summer, or 5 per cent on each side of the normal, and will generally be as much as 3 or 4 per cent on each side. Few good comparisons of the effect of the season on velocity are available, but there is good reason to suppose the variation to be not greater than half that of the pressure, probably rarely exceeding 2 per cent on each side of the normal, and generally falling considerably within that value.

It is to be observed that while an exposure of the cartridges in a magazine between the removal of the powder from the hermetically sealed boxes and the firing does not generally sensibly affect the powder, it does sometimes affect it very materially. It is my opinion that brown powder should never be exposed, but the cartridges should be placed in storage cases as soon as made, and left there till the time of firing.

Packing boxes.—The Department being dissatisfied with the wooden and iron barrels heretofore used for packing powders, a new packing box has been devised, intended to constitute a strong package for transportation, of convenient size and shape for handling and storage, and hermetically sealed, for the better preservation of the powder. The box is of the general design approved by experience and now ordinarily employed for military powders, of wood lined with tin, and sealed by a rubber gasket. The box as now made is of inch pine, well fastened with brass nails, and with a cut three-eighths inch wide and a full one-eighth inch deep, rabbeted in the inside of the upper edge. The lining is of a light but good quality of tinned iron. This is well fitted to the box and soldered at all joints. The sides come up nearly flush with the edge of the box, and then the tin is folded back outward on itself and then outward again to form a flange which lies in the rabbet, thus forming a groove in which the gasket lies. The gasket is of rubber three-sixteenths inch in cross section, and thus projects about one-third of its thickness above the edge of the box when the cover is off. The tin cover lining rests on the gasket all around, and the wood cover is screwed down firmly, the wood coming down to a bearing on the edge of the box and preventing undue or variable compression of the rubber in handling or piling for storage. The cover is fastened with brass screws, and is furnished with countersunk washers to protect the wood from abrasion by the head of the screw, and so add to its holding power. The box is furnished with cleats and rope handles for handling, and painted an olive lead color. Its cost is about $1.50. The dimensions are not necessarily fixed, though it is desirable to use as few sizes as practicable and have each size practically uniform, in order to admit of conveniently using over and over again. The size employed for charcoal powders has clear inside dimensions of 18¾ by 18½ by 18¼ inches. It holds 103 pounds at gravimetric density unity, and is intended to contain 100 pounds of granular, about 115 pounds of sphero-hexagonal, and 150 pounds of brown prismatic powders. The dimensions are adapted to the convenient packing of the latter. As smokeless powders are generally of less gravimetric density than charcoal powders, it is probable that a larger box will be found more suitable for packing them.

Cartridge storage cases.—A sealed case for the storage of cartridges ready for use in the gun is described in the Report of the Chief of Ordnance for 1893. But the cost of this case is considerable, and to replace it a wooden case has been devised, lined with tin and sealed with a gasket of rubber or similar material, and costing only about $4. The construction and materials are similar to the packing box above described, but the top is fastened on differently. An iron bar crosses above the cover, pivoted at the center, the ends of which engage under the inclined ends of two ears attached to the box. When the bar is rotated its ends are forced downward by these inclined planes and the cover brought to bear firmly on the gasket. Handles for carriage are attached to the ears.

Granulation of molded powders.—Steps have been taken to make the granulation of prismatic and sphero-hexagonal powders quite uniform, so that it can be used in making changes or even in putting up charges without scales, if necessary. The granulations of the three sizes of sphero-hexagonal powders are 64, 96, and 128 to the pound, or 4, 6, and 8 to the ounce. These sizes are intended for the 8-inch converted rifle and 15-inch smoothbore, the 12-inch mortars and siege cannon of all kinds, and the field cannon, respectively. Each size can, if desirable, be used for the manufacture of the class or classes for which the next size is intended, and hence the output of any particular kind of powder doubled in case of need, and even tripled in the case of the powder for siege cannon and 12-inch mortars.

The presses now installed for the manufacture of brown prismatic powder do not readily admit of the production of a grain weighing a simple aliquot part of a pound, but they can produce a uniform granulation throughout any lot of powder, and this is habitually determined for each lot and marked on the packing box.

Designation of powders.—There has been adopted during the year, with the approval of the Department, a system of designating the different powders and the different lots, and of marks for the packages containing them. Under this system the manufacturer's private marks are dropped and each lot is designated by the kind of powder, the piece for which intended, the name of the manufacturer or place of manufacture, the number of the lot of that kind of powder delivered from that factory during the year, and the year of delivery, a new series of numbers beginning with each year. The packages are marked with the designation of the lot, the granulation, and the weight of the powder contained. Thus:

150 lbs. Gran. 10.
Brown Prismatic Powder.
12" B. L. Mortars, U. S. A.
Du Pont, Lot No. 1, 1896.

or—

100 lbs. Gran. 650.
Maxim-Schüpphaus Smokeless Powder.
3.2" Field Guns, U. S. A.
Maxim, Lot No. 3, 1896.

By a "lot" is meant that quantity of powder which is manufactured and blended together so as to be uniform throughout its extent. The density is omitted from the designation, as it is often misleading to the user. Samples representing lots are indicated by the addition of a letter to the lot number. Thus, the sample selected to represent the first of the above lots on proof would be called Du Pont, sample No. 1 A, 1896. If the first sample failed, or for any other reason a second were taken, it would be called Du Pont, sample No. 1 B. Samples furnished by manufacturers for test for information are designated either by the manufacturer's private marks or by a serial number, omitting the year, as Du Pont, sample No. 2.

Service charcoal powders.—Although it is anticipated that smokeless powders will soon be adopted for the greater portion of our cannon, it has been thought well to have the manufacture of charcoal powders well systematized so that we might have recourse to them without delay if necessary to supplement the supply of smokeless powder in time of emergency.

The following may be considered the system of charcoal powders for the use of our service:

Black granular, .45-caliber Springfield rifle; granulation, 0.03–0.06 inch.
Black granular, 3-inch Hotchkiss mountain gun; granulation, 0.10–0.15 inch.
Black sphero-hexagonal for field cannon; granulation, 128.
Black sphero-hexagonal for siege cannon and 12-inch mortars; granulation, 96.
Black sphero-hexagonal for 8-inch converted rifles and 15-inch smooth-bore guns; granulation 64.
Brown prismatic for 12-inch B. L. mortars; granulation, 10 (about).
Brown prismatic for 8-inch B. L. rifle; granulation, 10 (about).
Brown prismatic for 10-inch B. L. rifle; granulation, 10 (about).
Brown prismatic for 12-inch B. L. rifle; granulation, 10 (about).

All of these powders have been manufactured by the Du Pont Company since this office was established. The detailed records of the manufacture are on file and the company has the molds and presses on hand, so that no difficulty is anticipated in producing promptly any kind that may be called for.

Saluting-powder charges.—The saluting powder recently adopted has been found to be so much more efficient for blank cartridges than the ballistic powders formerly used as to admit a reduction of the charge to about three-fifths that formerly employed. Accordingly the blank charges for the field gun, and 8 and 10 inch smooth-bore guns have been reduced from 2½, 10, and 15 pounds, respectively, to 1½, 7, and 10 pounds.

Considerable difficulty has been experienced in keeping the blank cartridge of the field gun in the chamber and sufficiently near the breech to secure certain ignition by the primer. But experiments at the Proving Ground show that this difficulty can be overcome by making the cartridge of the full diameter of the chamber, so that it will not slide forward into the bore, and that even when such a cartridge is pushed as far forward in the chamber as it will go, the ordinary friction primer will ignite it with certainty, the cartridge bag being made of the serge ordinarily employed for field guns.

SMOKELESS POWDERS.

Satisfactory advance in the development of smokeless powders has been made during the year, but it has been more in the direction of investigation into the properties and relative advantages and disadvantages of various compositions than in that of the development of higher ballistic properties. A set of comparative experiments has been carried on in the .30-caliber rifle and the 3.2-inch field gun with metallic case ammunition with powders of five compositions, designated herein by the letters A to E. Composition A was the Maxim-Schüpphaus composition, but required by the Ordnance Department to contain 10 per cent of nitroglycerin. (It is understood that the Maxim Company furnishes powder containing nitroglycerin or not, as may be desired.) Composition B was the "Peyton" composition. Composition C consisted of plain gun cotton, yielding about 13 per cent of nitrogen. Composition D contained 25 per cent of nitroglycerin, the remainder being low-grade gun cotton yielding 11 per cent nitrogen. Composition E is the "W.-A." XX powder. These compositions were selected as typical of the various compositions known to be suitable for powders, most of which consist substantially of gun cotton, high or low grade, with or without nitroglycerin and nitrates. In what manner and degree the selected compositions are typical can not be described without disclosing the ingredients and proportions of the compositions designated above by the names of the makers. But I may say that composition D was proposed by me on the theory, stated in my last annual report, that the considerable amount of comparatively cool gas furnished by the low-grade gun cotton would modify the heat and erosive effects of the nitroglycerin, while the considerable proportion of nitroglycerin would contribute the good ballistic qualities which powders containing this substance so generally possess; and further, that the use of a gun cotton soluble in nitroglycerin might tend to prevent its separation in storage or under climatic influences. These compositions were made up into powders suitable for the .30-caliber rifle and the 3.2-inch field gun, except that composition E was not used in the latter piece. The results of the experiments are stated in connection with the further discussion.

The subject divides naturally into three portions, relating respectively to ballistics, stability, and erosion.

Ballistics.—The present state of the development of smokeless powder for the military service, as regards ballistics, is shown by the following table of results obtained with powders of domestic manufacture:

Piece and projectile.	Charge.	Pressure per square inch.	Muzzle velocity.	Remarks.
	Grains.	*Pounds.*	*Ft. sec.*	
.30-caliber service rifle and ammunition.	37.0	35,000	2,000	Peyton.
	41.7	34,000	2,000	W.-A.
	Ounces.			
6-pounder R. F. gun, .45-caliber, 54 cubic-inch chamber.	19.4	33,600	2,400	Maxim-Schüpphaus.
3.2-inch field gun, service, 13½ pounds.	20.75	28,500	1,685	Du Pont, plain gun cotton.
3.6 inch field gun, service..	25.0	28,500	1,540	Same powder as preceding.
3.6-inch field mortar, service, 20 pounds.	9.0	14,800	660	Du Pont, plain gun cotton.
3.2-inch field gun, metallic case, 16½ pounds.	16.0	28,000	1,450	Peyton.
	24.5	23,500	1,450	W.-A.
	17.75	28,000	1,450	Maxim, plain gun cotton.
	19.0	25,000	1,450	Maxim-Schüpphaus.
	20.0	28,000	1,450	Du Pont, plain gun cotton.
	15.75	28,000	1,450	Du Pont, low-grade gun cotton, 25 per cent nitroglycerin.
	Pounds.			
5-inch siege gun, service, 45 pounds.	5.6	21,800	1,830	Same powder as preceding.
	5.0	21,000	1,830	Maxim-Schüpphaus.
7-inch siege howitzer, service:				
105 pounds	4.75	15,000	1,100	Same powder as preceding.
125 pounds	5.0	17,600	1,075	Do.
7-inch siege mortar, service, 125 pounds.	3.12	15,000	725	Du Pont, plain gun cotton.
8-inch B. L. rifle, service, 300 pounds.	78	34,200	2,272	Maxim-Schüpphaus.
10-inch B. L. rifle, service, 575 pounds.	128	34,500	2,224	Do.
12-inch B. L. rifle, service, 1,000 pounds.	220	36,000	2,200	Do.
12-inch B. L. mortar:				
Cast-iron, service, 800 pounds.	38	26,300	1,140	Same powder as in 8-inch rifle above.
Steel, service	47	29,700	1,260	Do.
1,000 pounds	11.5	5,000	500	Maxim-Schüpphaus, for reduced charges.

For the small arm and the field and siege cannon the velocity is fixed by conditions of sights, recoil, etc., and ballistic excellence is utilized in reducing the charge. For the other pieces the highest practicable initial velocity is desired.

Experiments have not proceeded sufficiently far as yet with all these powders to determine their ballistic uniformity; such observations as have been made have indicated a degree of uniformity as high as or higher than for charcoal powders. A report from Frankford Arsenal states that 1,000 targets of 10 shots each at 500 yards made there in the regular daily tests of the output gave an average mean variation for the magazine rifle with Peyton powder only about four-fifths as great as the corresponding value for the same number of targets made with the Springfield rifle and black powder. Also, in the tests with the 3.2-inch field gun above described, six 5-shot groups were made with each kind of powder and the initial velocities measured. The various groups were fired with portions of the powders that had been subjected to treatment of various kinds, moisture, cold, heat, etc. The means, for each of the different compositions, of the mean variations of velocity for each group are as follows: Composition A, 2.16 feet per second; composition B, 3.83 feet per second; composition C, 3.74 feet per second, and composition D, 3.20 feet per second. These results are regarded as excellent. Another comparison is furnished by 4 targets of 4 shots each that were made with the 12-inch steel mortar, two at about 2,000 yards range with 1,000-pound shell, and two at about 6,850 yards with 800-pound shell. One target at each range was made with smokeless powder and the other with charcoal powder, the two kinds being fired alternately. The mean variations in range were, for the smokeless powder 12 yards and 22 yards, respectively, and for the charcoal powder 14 yards and 12 yards. The smokeless powder giving the variation 22 yards was not well suited to the piece, being too slow to give the best results at so short a range as 6,850 yards. Also, two targets of 10 shots each, firing alternately, were made with the 3.6-inch field mortar, using black and smokeless powders. The mean range with the black powder was 976 yards and the total dispersion 131 yards, and for the smokeless powder 1,340 yards and 128 yards, respectively.

We may therefore conclude that the advent of smokeless powder will lead to an increase in accuracy as well as an increase in power.

Stability.—In this term is included both chemical stability, or resistance to chemical change, and mechanical stability, or resistance to such changes as separation of nitroglycerin, evaporation of ingredients, and other changes of the state of agglomeration.

The chemical stability is, in general, that of the ingredients, and can be assured in a satisfactory degree by careful manufacture of the latter. When well made throughout, the chemical stability of the approved types has been found to be quite sufficient for the purpose in view, so that no trouble is anticipated on this score.

The mechanical stability of the approved varieties is even more satisfactory. The colloidal character of these powders and the insolubility of their principal ingredients in water are favorable qualities, and within the ordinary limits alternating changes of temperature and moisture do not appear to seriously affect them.

Considerable evidence regarding stability has been obtained from the powder tests made in connection with the erosion tests above described. All of the five compositions showed an increase in the velocity and pressure when heated and fired hot, and a loss when fired cold, but it is thought that the changes were no greater than charcoal powders would show under similar conditions. They are but slightly affected by moisture, and almost none at all by drying beyond the normal state. In this most important respect they are quite beyond comparison with charcoal powders. Moisture does not appear to affect the interior of the grain at all, and only affects the results through its presence on the surface; and the qualities of the powder are completely restored by drying in the open air. Compositions A, B, C, and D, in the form of field-gunpowder, were kept submerged in water for 15 hours, and after drying in the air showed no loss of ballistic effect. And all five compositions in small-arm powder were subjected for 30 minutes to a temperature of 10° F. below zero, and then raised to a temperature of about 80° F., alternately, 30 times, and showed no change either in ballistic effects or under the microscope.

As regards the propriety of the use of nitroglycerin as an ingredient of a military powder there are great differences of opinion. All must admit its very important good qualities of giving high ballistic results and facilitating the manufacture. The disadvantages usually alleged against its use are great erosive effect and lack of chemical and mechanical stability. The former will be discussed later; as for the latter, there appears to be no good reason to doubt its equality with gun cotton in chemical stability, while, when used in proper proportions and manner, its mechanical stability also appears to be well assured. Indeed, I have never heard of a case of the failure of a well-made powder containing less than 60 per cent of nitroglycerin on this score, while powders containing nitroglycerin have been much experimented with, and are to-day widely used.

Erosion.—The erosive effects of smokeless powders are generally considered to be serious. Nevertheless, it is thought that this defect is not so serious as to counterbalance the advantages attendant on their use. Smokeless powder will be adopted, whatever the erosiveness. But it is important that the powders that are satisfactory in other respects be examined in relation to this one, in order that the most advantageous compromise between the good and the bad may be made. It is this consideration that led to the experiments with the five smokeless powder compositions above described, which were undertaken mainly for a determination of their erosiveness, and whether the heating and erosive effects were in any sense proportional, so that the latter might be predicted in general terms from the former.

The following table shows for these powders the theoretical temperatures of explosion as calculated from the approximate compositions, the actual rise of temperature of the barrel of the .30-caliber rifle due to firing 25 shots, the values given being the mean of eight determinations at rates of firing ranging from one per minute to as fast as possible, and the relative order in erosive effect as determined by examination of the barrels cut open after 5,000 rounds:

A.	B.	C.	D.	E.
2,830 C.	3,000	2,680	2,550	....
114 F.	117	99	97	137
3	4	2	1	5

The erosions produced by No. 1 were quite slight, those by No. 5 very great. They were mainly confined to a space within 2 inches of the seat of the bullet, and had caused no loss of velocity except in the case of composition E, in which the velocity had fallen off about 150 feet. This caused a drop on the target, but for none of the compositions was the "cluster" impaired.

The compositions arrange themselves in the same order in heating and erosive effects, and not only that, but the intervals are much the same. The interval between Nos. 1 and 2 in erosive effect is the least, and the successive intervals increase in rapid ratio up to that between Nos. 4 and 5, which is very great. This result indicates strongly that the relative erosive effects of such powders may be predicted with considerable accuracy from their composition and relative heating effects, other conditions being the same, and the weight of this indication is greatly increased by its agreement with the conclusion to which we are conducted by a consideration of the conditions and most probable causes of erosion, that whether the proximate cause of erosion be of a mechanical or a chemical nature, heat is the original disposing cause.

The principal products of explosion of the smokeless powders of to-day are N, H, CO_2, and H_2O. The proportion of O varies with the different substances employed as ingredients, and the proportion of H and CO to H_2O and CO_2 will vary according to the composition of the powder. As the proportion of the two latter compounds rises the temperature of explosion will increase, and, judging from the results of the experiments cited, the erosion also. Now, nitroglycerin contains more than enough O to burn all its H and C to H_2O and CO_2, while high-grade gun cotton burns about half of these elements, and low-grade about one-third, to H_2O and CO_2. We may therefore control the temperature through the composition. Thus, in cordite the addition of 5 per cent of vaseline, a pure hydrocarbon, reduces the temperature of the 58 per cent of nitroglycerin and 37 per cent high-grade guncotton to that given by ballistite consisting of equal parts of nitroglycerin and low-grade gun cotton; and the use of low-grade gun cotton with 25 per cent of nitroglycerin in composition D reduces the temperature to that given by high-grade gun cotton alone in composition C.

It would seem, therefore, that the erosive effect can be approximately predicted from a determination of the heating effect, and both with some degree of approximation from a knowledge of the composition; and further, that the great heat of nitroglycerin can be so modified by the use of other suitable ingredients in a powder as to reduce the heat and erosion to any desired point. The logical conclusion appears to be that there is no objection on the score of erosion to the use of nitroglycerin, with suitable accompanying ingredients, in smokeless powder.

Form of grain.—In my last annual report I stated that the colloidal smokeless powders, unlike the charcoal powders, possess the property of burning by parallel surfaces in the gun. This property is a very important one, and enables the powder maker to fully realize the theoretical advantages of a progressive combustion of the charge based on the amount of burning surface, long striven for, but never obtained with charcoal powders. An example showing the effect of the form of grain occurred in my experience during the year. Working with a fixed composition, I endeavored by varying the thickness of a flat grain about three-eighths of an inch square to adapt it to the field gun. The best results obtainable were 32,000 pounds pressure for the standard velocity of 1,450 feet per second. I then had the same material made in the form of a 7-perforated cylindrical grain, and got at the first trial 1,450 feet per second with 26,500 pounds pressure. The "progressiveness" of these forms, as defined in my report in the Report of the Chief of Ordnance for 1895, is about 0.6 and 1.2, respectively.

From the method of combustion by parallel surfaces and the low velocity of such combustion it results that at least one of the dimensions of the grain of smokeless powder must be small. If, then, the powder be made in solid grains of a generally cubical or spherical form, they will be so small as to hinder the inflammation of the charge, and so give rise to irregular velocities and abnormal pressures. The most obvious method of obviating this difficulty is to make the powder in the form of rods or strips, which is a very usual form and very favorable to regular inflammation.

But, then, this form is less progressive than the multiperforated cylinder, and as by increasing the number of perforations a grain of any desired size may be obtained for any given thickness of the walls between the perforations, it would seem that by this method a free and unhindered inflammation of the charge could be obtained and at the same time a considerable increase of ballistic power realized. Moreover, this form is a strong one and resists breakage or crushing better than the strip form, and consequently tends to regularity of results.

All things considered, the perforated cylinder or disk proposed by General Rodman many years ago, and recently revived in the Maxim-Schüpphaus powder, appears to me to be the most suitable and promising form for the colloidal smokeless powders. For the small arm the mechanical difficulties of manufacturing and loading such a form are at present not practically surmounted, but it is already adapted to nearly all of our service cannon. As to the length, the longer the better, provided the grain be not so long as to cause it to be burst by the gas formed in the perforations.

We have now at our command several types of smokeless powder of domestic manufacture, which have shown themselves to be possessed of satisfactory stability so far as can be shown without long exposure to service conditions, and the erosiveness of which will probably be within allowable limits. The next step is to procure them for the current firing of the Department and service, in order to enable the manufacturers to adjust the grain to the ballistic conditions and develop suitable methods of manufacture, and also by trial to eliminate the less and develop the more efficient types and so determine finally the most satisfactory type or types for adoption for service use.

INSPECTION OF POWDER.

The following orders and contracts have been in process of execution under my inspection during the year ending June 30, 1896:

With E. I. Du Pont de Nemours & Co.:

(1) Contract dated April 26, 1892, for 223,200 pounds brown prismatic powder for 8-inch, 10-inch, and 12-inch rifles.

(2) Contract dated February 17, 1894, for 85,000 pounds brown prismatic powder for 10-inch rifles (Woodbridge, Crozier, and service).

(3) Order dated September 26, 1894, for 500 pounds smokeless powder for 8-inch rifle.

(4) Contract dated June 3, 1895, for 2,500 pounds smokeless powder for .30-caliber rifle.

(5) Order dated June 18, 1895, for 25 pounds shell powder.

(6) Contract dated August 10, 1895 (Frankford Arsenal), for 20,000 pounds black powder for Springfield rifle.

(7) Contract dated August 1, 1895, for 10,000 pounds saluting powder for seacoast cannon.

(8) Contract dated December 2, 1895, for 26,000 pounds black sphero-hexagonal powder for siege cannon and 12-inch mortars, 65,000 pounds brown prismatic for 12-inch mortars, 90,000 pounds for 8-inch rifle, 120,000 pounds for 10-inch rifle, and 202,000 pounds for 12-inch rifle.

(9) Contract dated January 13, 1896, for 950 pounds of smokeless powder for .30-caliber rifle and 3.2-inch field gun, consisting of four lots for special tests.

(10) Contract dated January 27, 1896, for 75,000 pounds saluting powder for field guns.

(11) Order dated May 20, 1896, for 200 pounds smokeless powder for 3.6 and 7 inch mortars.

(12) Contract dated May 26, 1896, for 25,000 pounds black sphero-hexagonal powder for 15-inch guns.

With the Maxim Powder and Torpedo Company:

(13) Contract dated January 13, 1896, for 850 pounds smokeless powder for .30-caliber rifle and 3.2-inch field gun, in lots for special tests.

With Laflin and Rand Powder Company:

(14) Contract dated January 27, 1896, for 75,000 pounds saluting powder for field guns.

With Atlantic Dynamite Company:

(15) Contract dated June 22, 1896, for 1,500 pounds emmensite.

At the end of the year Nos. 1, 2, 4, 5, 6, 7, 9, 10, and 14 had been completed.

Under these orders and contracts the following amounts of powder have been delivered during the fiscal year:

	Pounds.
For .30-caliber rifle, smokeless	2,800
For .45-caliber rifle, black	20,000
For 3.2-inch field gun, smokeless	800
For 12-inch mortars, brown	41,723
For 10-inch rifles, brown	105,968

	Pounds.
For 12-inch rifles, brown	55, 284
For field guns, saluting	160, 000
For seacoast guns, saluting	10, 000
For shells, black	25

The following table shows the ballistic requirements and results obtained on proof for the cannon powders delivered. The small arms powders are tested and accepted at Frankford Arsenal:

Date of contract.	Lot of powder.		Proof.				
	Designation.	Weight.	Gun.	Charge.	Projectile.	Pressure per square inch.	Muzzle velocity.
		Pounds.		*Pounds.*	*Pounds.*	*Pounds.*	*Ft. sec.*
Apr 26, 1892	Requirement		10-inch rifle	245	575	37, 000	1, 975
	V. U., lot 22	9, 003	do	260	575	37, 000	2, 000
	W. Z., lot 5 (experimental).	22, 341	12-inch rifle	485	1, 000	39, 000	2, 030
	Requirement		do	450	1, 000	37, 000	1, 975
	W. Z., lot 6	32, 943	do	460	1, 000	38, 500	2, 050
Feb. 17, 1894	Requirement		10-inch rifle (Crozier).		575	42, 500	
	X. A., lot 3	20, 516	do	283	575	43, 000	2, 072
	X. A., lot 4 (for 10-inch rifle, Crozier).	10, 000	10-inch rifle	280	575	34, 500	2, 000
Dec. 2, 1895	Brown prismatic, 12-inch mortars, requirement.		12-inch C. I. mortar.	75	800	27, 500	1, 020
	Du Pont, lot No. 1, 1896	41, 723	do	75	800	26, 400	[a]1, 010
	Brown prismatic, 10-inch rifles, requirement.		10-inch rifle	280	575	38, 000	2, 025
	Du Pont, lot No. 1, 1896	66, 449	do	265	575	37, 200	2, 015

[a] Tested in December. In May this same lot gave 27,500 pounds pressure and 1,020 feet per second with same charge.

Little remark respecting the execution of these contracts is called for. Order No. 3, for 500 pounds of smokeless powder for 8-inch rifle, has not been filled. This order was given merely for the purpose of encouraging the manufacturers to experiment, and as the Du Pont Company is carrying on the experiments, and prefer to await their conclusion before delivering the powder, I have been quite willing to consent to the delay. The small-arms powders are tested and accepted at Frankford Arsenal, but I have exercised a general supervision of the manufacture. The order for black sphero-hexagonal powder for 15-inch guns was given to determine a suitable powder for use in both the 8-inch converted rifle and the 15-inch smoothbore, and to insure the existence of suitable plates for its manufacture.

Very respectfully, your obedient servant,

SIDNEY E. STUART,
Captain, Ordnance Department, Inspector.

The CHIEF OF ORDNANCE, UNITED STATES ARMY,
Washington, D. C.

APPENDIX 19.

PROGRESS REPORT OF MANUFACTURE OF STEEL FORGINGS, ETC., AT MIDVALE STEEL WORKS, PHILADELPHIA, PA., DURING THE FISCAL YEAR ENDING JUNE 30, 1896.

MIDVALE STEEL WORKS,
Philadelphia, Pa., September 1, 1896.

SIR: I have the honor to transmit the following report upon the operations undertaken for the Ordnance Department, United States Army, by the Midvale Steel Company for the fiscal year ended June 30, 1896.

All information relative to manufacture is omitted from this report upon the request of the Midvale Steel Company. The right to make this request is granted in the specifications embodied in the contracts, and all information given by the company is to be considered as confidential, and for the use of the Department only.

List of fabrications.

STEEL FORGINGS.

No. of contract or order.	Date of contract or order.	Date of expiration of contract or extension of contract.	Fabrication.
1	June 15, 1891	Dec. 16, 1896	9 sets of steel forgings for 12-inch B. L. rifle, model 1888.
2	June 12, 1895	Mar. 10, 1896	2 sets of steel forgings for 12-inch B. L. rifle, model 1888 M$_{II}$.
3	Oct. 18, 1894	Sept. 5, 1895	5 sets of steel forgings for 10-inch B. L. rifle, model 1888 M$_{II}$.
[a] 4	June 15, 1891	Mar. 1, 1896	1 extra set of steel forgings for 10-inch B. L. rifle, model 1888 M$_{II}$.
5	June 12, 1895	Dec. 29, 1895	4 sets of steel forgings for 8-inch B. L. rifle, model 1888 M$_{II}$.
6	Apr. 6, 1896	June 8, 1896	1 set of steel forgings for 5-inch R. F. gun.
7	June 17, 1895	Oct. 18, 1895	10 sets of steel forgings for 3.6-inch B. L. R. field mortar.
8	.....do......	Jan. 8, 1896	155 12-inch deck-piercing mortar shells.
9	.....do......	Oct. 15, 1895	104 10-inch A. P. shot.
10	Apr. 29, 1896	June 10, 1896	20 8-inch tempered steel shells.
11	Oct. 2, 1895	Oct. 23, 1895	25 steel forgings for 3.2-inch B. L. rifle, viz, 5 breechblocks, 5 spindles, 5 block carriers, 10 gas checks.
12	Jan. 13, 1896	Feb. 17, 1896	5 steel forgings for 4.7 inch Gerdom R. F. gun for Watervliet Arsenal, viz, 1 breech piece, 1 breechblock, 1 face plate, 1 block carrier, 1 extractor.
13	Jan. 16, 1896	Jan. 20, 1896	1 steel forging for 3.2-inch Gerdom block carrier for Watervliet Arsenal.
14	Nov. 13, 1894	Mar. 14, 1896	6 steel deck plates.
15	Apr. 1, 1895	Nov. 5, 1895	428 steel forgings for 10-inch B.-C. disappearing carriage for Pond Machine Tool Company, Plainfield, N. J. (4 sets), viz. 4 gun-lever axles, 8 gun lever caps, 4 racer clips, 80 traversing rollers, 16 traverse-wheel axles, 4 elevating rods (right hand), 4 elevating rods (left hand), 8 elevating-rod caps, 4 elevating racks (right hand), 4 elevating racks (left hand), 8 buffer caps, 72 chassis rollers, 8 ratchet wheels, 8 ratchet-wheel pawls, 12 spanner wrenches, 4 suspension-rod shafts, 72 chassis-roller axles, 8 suspension rods, 8 pistons and rods combined, 4 clamp levers, 4 ratchet levers (right hand), 4 ratchet levers (left hand), 4 pawl cranks (right hand), 4 pawl cranks (left hand), 4 crosshead ratchet pawls (right hand), 4 crosshead ratchet pawls (left hand), 4 crosshead stationary pawls (right hand), 4 crosshead stationary pawls (left hand), 8 tripping-bar eyebolts, 8 tripping bars, 8 holding-down shafts with pinions and couplings, 8 traversing gear cranks, 4 crane crank shafts and pinions combined, 4 crane ratchet wheels, 4 crane pawls, 4 crane eyebolts, 4 crane block hooks, 8 crane cranks.

[a] Extended to March 11, 1896.

List of fabrications—Continued.

STEEL FORGINGS—Continued.

No. of contract or order.	Date of contract or order.	Date of expiration of contract or extension of contract.	Fabrication.
16	Sept. 24, 1895	Oct. 15, 1895	20 steel billets (forged steel, No. 1) for Watertown Arsenal, viz: 13 billets 4 by 4 by 60 inches, 2 billets 5 by 5 by 75 inches, 5 billets 8 by 8 by 48 inches.
17	.....do......	.....do......	54 steel billets (forged steel, No. 3) for Watertown Arsenal, viz, 5 billets 5 by 5 by 45 inches, 3 billets 8½ by 8½ by 75 inches, 17 billets 9 by 9 by 60 inches, 5 billets 11 by 11 by 35 inches, 3 billets 11 by 11 by 73 inches, 15 billets 12 by 12 by 60 inches, 1 billet 12 by 12 by 80 inches, 5 billets 14 by 14 by 46 inches.
18	Oct. 4, 1895	Immediate..	2 steel billets (forged steel, No. 3) for Watertown Arsenal, viz, 1 billet 14 by 17 by 74 inches, 1 billet 14 by 17 by 111 inches.
19	Aug. 6, 1896	.....do......	3 steel forgings for base plugs for 7-inch shell.
20	Apr. 17, 1896	.....do......	9 steel billets for 7-inch mortar carriages for Watertown Arsenal, viz, 6 billets 5 by 5 by 90 inches (forged steel, No. 2), 2 billets 7½ by 7½ by 55 inches (forged steel, No. 3), 1 billet 10 by 10 by 70 inches (forged steel, No. 3).
21	.....do......	.....do......	57 steel billets (forged steel, No. 3) for 10-inch disappearing carriage for Watertown Arsenal, viz, 3 billets 4 by 4 by 120 inches, 2 billets 5 by 5 by 112½ inches, 1 billet 6 by 6 by 55 inches, 2 billets 7 by 7 by 75 inches, 1 billet 8 by 8 by 90 inches, 5 billets 8 by 8 by 71 inches, 4 billets 8½ by 8½ by 75 inches, 10 billets 9 by 9 by 120 inches, 5 billets 11 by 11 by 36 inches, 5 billets 11 by 11 by 77 inches, 5 billets 12 by 12 by 50 inches, 10 billets 12 by 12 by 60 inches, 1 billet 14 by 17 by 128 inches, 1 billet 14 by 17 by 192 inches, 2 billets 6 by 6 by 60 inches.
22	.....do......	.....do......	24 steel billets for 12-inch barbette carriages for Watertown Arsenal, viz, 2 billets 12 by 12 by 50 inches (forged steel, No. 2), 4 billets 5 by 5 by 56 inches (forged steel, No. 3), 2 billets 6 by 6 by 70 inches (forged steel, No. 3), 4 billets 6 by 6 by 90 inches, (forged steel, No. 3), 8 billets 10 by 10 by 65 inches (forged steel, No. 3), 4 billets 14 by 14 by 65 inches (forged steel, No. 3).
23	.....do......	.....do......	20 steel billets (forged steel, No. 3) for 12-inch disappearing carriage for Watertown Arsenal, viz, 2 billets 5 by 5 by 60 inches, 1 billet 5 by 5 by 80 inches, 1 billet 12 by 12 by 50 inches, 6 billets 12 by 12 by 60 inches, 2 billets 13 by 13 by 84 inches, 1 billet 14 by 14 by 54 inches, 1 billet 14 by 14 by 72 inches, 1 billet 20 by 20 by 77 inches, 5 billets 14 by 14 by 46 inches.
24	.....do......	.....do......	2 steel billets for 15-inch barbette carriage for Watertown Arsenal, viz, 2 billets 9 by 9 by 12 inches (forged steel, No. 2).
25	July 29, 1896	Aug. 29, 1896	32 steel billets for 7-inch mortar carriages for Watertown Arsenal, viz, 20 billets 5 by 5 by 90 inches (forged steel, No. 2), 7 billets 7½ by 7½ by 55 inches (forged steel, No. 3), 5 billets 10 by 10 by 80 inches (forged steel, No. 3).
26	.....do......	.....do......	59 steel billets (forged steel, No. 3) for 8-inch disappearing carriage for Watertown Arsenal, viz, 1 billet 4 by 4 by 48 inches, 5 billets 4 by 4 by 54 inches, 2 billets 5 by 5 by 45 inches, 2 billets 6 by 6 by 72 inches, 4 billets 7 by 7 by 72 inches, 15 billets 7½ by 7½ by 54 inches, 5 billets 8 by 8 by 50 inches, 5 billets 9 by 9 by 40 inches, 3 billets 9 by 9 by 41 inches, 1 billet 9 by 9 by 42 inches, 5 billets 9 by 9 by 55 inches, 5 billets 9 by 9 by 81 inches, 1 billet 9 by 9 by 115 inches, 5 billets 10½ by 10½ by 48 inches.
27	.....do......	.....do......	24 steel billets (forged steel, No. 3) for 12-inch B. L. R. carriages for Watertown Arsenal, viz, 4 billets 5 by 5 by 56 inches, 2 billets, 6 by 6 by 70 inches, 4 billets 6 by 6 by 90 inches, 8 billets 10 by 10 by 65 inches, 2 billets 12 by 12 by 50 inches, 4 billets 14 by 14 by 65 inches.

STEEL CASTINGS.

28	Apr. 1, 1895	Nov. 5, 1895	160 steel castings for 10-inch B. C. disappearing carriage, made for Pond Machine Tool Co., Plainfield, N. J. (4 sets), viz, 8 gun levers, 4 cross-head clips (right hand), 4 cross-head clips (left hand), 4 racers, 16 traverse wheels, 4 traverse-wheel transoms, 8 traversing-gear clamps, 4 chassis (right hand), 4 chassis (left hand), 8 rear-cylinder heads, 4 elevating-rod separators, 4 elevating-rack guides (right hand) without pockets, 4 elevating-rack guides (left hand) without pockets, 4 elevating-rack guides (right hand) with pockets, 4 elevating-rack guides (left hand) with pockets, 4 elevating bands, 4 brackets for retracting gear with seat for sight standard, 4 brackets for retracting gear without seat for sight standard, 4 sight standards, 8 buffer brackets, 4 front transoms, 4 rear transoms, 8 spur gears, 8 chain-pulley brackets, 4 chain wheels, 4 worm wheels, 8 chain-pulley wheels, 4 traversing-gear brackets, 8 cap squares.

List of fabrications—Continued.

STEEL CASTINGS—Continued.

No. of contract or order.	Date of contract or order.	Date of expiration of contract or extension of contract.	Fabrication.
29	July 29, 1895	Immediate..	210 steel castings for 10-inch B. C. disappearing carriage for Watertown Arsenal (5 sets), viz, 10 gun levers, 5 racers, 20 traverse wheels, 5 traverse-wheel transoms, 10 traverse-gear clamps (5 right, 5 left), 10 chassis (5 right, 5 left), 10 cap squares, 10 rear-cylinder heads, 5 elevating-rod trusses, 5 elevating bands, 10 elevating-rack guides (5 right, 5 left), 10 elevating-rack guides (5 right, 5 left), 5 sight standards for chassis, 5 brackets for chassis-sight standards, 5 brackets for retracting gears, 10 buffer brackets, 5 front transoms, 5 rear transoms, 10 spur wheels, 10 chain-pulley brackets, 10 chain pulleys, 5 chain wheels, 5 worm wheels, 5 traversing-gear brackets, 10 cross-head clips (5 right, 5 left), 10 buffer-rack brackets.
30	Feb. 26, 1896	.....do	5 chassis (3 right, 2 left) for 10-inch B.C. disappearing carriage for Kilby Manufacturing Co., Cleveland, Ohio.
31	June 17, 1896	.....do	2 chassis (2 left hand) for 10-inch B. C. disappearing carriage for Kilby Manufacturing Co., Cleveland, Ohio.
32	Aug. 6, 1896	.....do	30 open-hearth steel castings for 7-inch shell for Watervliet Arsenal.

OUTSIDE WORK.

Under this head are comprised fabrications made at works other than those of the Midvale Steel Company.

STEEL CASTINGS—Continued.

No. of contract or order.	Date of contract or order.	Date of expiration of contract or extension of contract.	Fabrication.
			MADE BY THE WM. CRAMP & SONS SHIP AND ENGINE BUILDING CO., PHILADELPHIA, PA.
33	Jan. 10, 1895	July 18, 1895	2 10-inch B. C. disappearing carriages.
34	Nov. 5, 1894	June 5, 1895	1 10-inch Spiller pneumatic disappearing carriage.
35	Oct. 21, 1895	Nov. 30, 1895	1 3.2-inch limited-recoil Driggs field carriage.
			MADE BY EUREKA STEEL CASTING CO., CHESTER, PA., FOR ROCK ISLAND ARSENAL.
36	Sept. 25, 1894	Immediate..	100 steel castings (cast steel, No. 1) for siege carriages, 88 steel castings (cast steel. No. 2) for siege carriages.
			MADE BY EUREKA STEEL CASTING CO., CHESTER, PA., FOR WATERTOWN ARSENAL.
37	April, 1896	.....do	2 cast-steel brackets for 15-inch barbette carriage.
			MADE BY PENN STEEL CASTING CO., CHESTER, PA., FOR WATERTOWN ARSENAL.
38	Mar. 16, 1896	.....do	215 steel castings for 10-inch B. C. disappearing carriage (5 sets), viz, 10 gun levers, 5 racers, 20 traverse wheels, 5 traverse-wheel transoms, 10 traverse-gear clamps (5 right, 5 left), 10 chassis (5 right, 5 left), 10 cap squares, 10 rear-cylinder heads, 5 elevating-rod trusses, 5 elevating bands, 10 elevating-rack guides (5 right, 5 left), 10 elevating-rack guides (5 right, 5 left), 5 sight standards for chassis, 5 brackets for chassis-sight standards, 5 brackets for retracting gears, 10 buffer brackets, 5 front transoms, 5 rear transoms, 10 spur wheels, 10 chain-pulley brackets, 10 chain pulleys, 5 chain wheels, 5 worm wheels, 10 elevating-rack buffer brackets, 10 cross-head clips, 10 elevating racks.
39	Mar. 27, 1896	.....do	26 steel castings for 12-inch barbette carriage (2 sets), viz, 2 top carriages, 4 cap squares, 4 rear-cylinder heads, 2 bearings for elevating shaft, 2 cheeks for chassis (right), 2 cheeks for chassis (left), 2 upper-roller paths, 8 guide hooks.
40	May 20, 1896	.....do	16 truck-wheel plates for 15-inch barbette carriage.

List of fabrications—Continued.

STEEL CASTINGS—Continued.

No. of contract or order.	Date of contract or order.	Date of expiration of contract or extension of contract.	Fabrication.
			MADE BY AMERICAN STEEL CASTING CO., THURLOW, PA., FOR WATERTOWN ARSENAL.
[a]41	Dec. 1, 1894	Jan. 4, 1895	7 steel castings for 12-inch gun-lift carriage, viz, 1 top carriage, 2 cheeks, 1 front transom, 1 upper-roller path, 1 front-racer clip, 1 rear-racer clip.
			MADE BY AMERICAN STEEL CASTING CO., THURLOW, PA., FOR POND MACHINE TOOL CO., PLAINFIELD, N. J. (4 SETS.)
42	Nov., 1895 (?)	Unknown ..	160 steel castings for 10-inch B. C. disappearing carriage (4 sets), viz, 8 chassis, 8 gun levers, 4 rear transoms, 4 front transoms, 8 cross-head clips, 16 traverse wheels, 4 worm wheels, 8 spur wheels, 8 chain pulleys, 4 chain wheels, 4 traverse-gear brackets, 4 retracting-gear brackets, 4 sight-standard brackets, 8 buffer brackets, 16 elevating-rack guides, 4 elevating-rod separators, 8 traversing-gear clamps, 8 chain-pulley brackets, 4 traverse-wheel transoms, 8 rear-cylinder heads, 4 elevating bands, 4 sight standards, 4 racers, 8 cap squares.
			MADE BY AMERICAN STEEL CASTING CO., THURLOW, PA., FOR WATERTOWN ARSENAL.
43	June 16, 1896	Sept. 14, 1896	30 steel castings (1 set) for 12-inch disappearing carriage, viz, 1 elevating arm, 1 elevating band, 1 counterweight cage, 2 transoms, 4 slide clips (2 right, 2 left), 2 elevating slides (1 right, 1 left), 1 racer, 2 buffer brackets (1 right, 1 left), 2 gun levers (1 right, 1 left), 1 yoke, 1 top carriage, 2 rear stuffing boxes, 1 ladder standard, 1 sight standard, 2 piston-rod brackets, 2 chain sheaves, 1 post, 1 platform base, 2 sight-standard caps.
44	July 1, 1896	Immediate..	26 steel castings (2 sets) for 12-inch barbette carriage, viz, 2 top carriages, 4 cap squares, 4 rear-cylinder heads, 2 bearings, 4 chassis, 2 upper-roller paths, 8 clips.
45	.....do......	Oct. 27, 1896	140 steel castings (5 sets) for 8-inch disappearing carriage, viz, 5 racers, 10 chassis (5 right, 5 left), 10 cap squares for top carriage, 20 traverse wheels, 5 traverse-wheel transoms, 10 gun levers (5 right, 5 left), 5 elevating clamps, 5 traverse-gear brackets, 10 traverse-clamp jaws (5 front, 5 rear), 5 elevating-arm trusses, 5 elevating bands, 10 transoms (5 front, 5 rear), 10 cross-head pieces (5 right, 5 left), 10 chain-pulley brackets, 10 elevating-spur wheels, 5 piston-rod rear brackets, 5 sight standards.

[a] Extended to February 20, 1895; applied for extension to August 1, 1895.

Of the above list, the following numbers have been completed: Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 36, 37, 39, 40, 41, and 42.

The stores represented by these numbers have been shipped to their respective destinations.

The unfinished work at the date of this report comprises Nos. 34, 35, 38, 43, 44, and 45.

I.—12-INCH B. L. RIFLE, MODEL 1888.

(*a*) CONTRACT OF JUNE 15, 1891, MODEL 1888.

This contract was for 9 guns, for which 6 sets of forgings were completed and shipped at the date of last report. The remaining 3 sets were finished and delivered as follows: One set on January 24, 1896, 1 on February 19, 1896, and 1 on March 6, 1896. The contract expired on December 16, 1896; hence the company had 9 months and 10 days to spare.

(*b*) Contract of June 12, 1895, Model 1888 M_{II}.

This contract for 2 sets of 12-inch forgings expired on March 10, 1896. The first set was finished December 6, 1895, and the second December 31, 1895, or 2 months and 10 days in advance of expiration of contract. All 12-inch forgings were shipped to Watervliet Arsenal, West Troy, N. Y.

II.—10-INCH B. L. RIFLE, MODEL 1888 M_{II}.

(*a*) Contract of October 18, 1894.

Five sets of forgings were made under this contract, which expired September 5, 1895. The last delivery was made September 24, 1895. Penalties were exacted on these sets at $10 per day for delay in delivery, for 91, 83, 68, 41, and 19 days, respectively.

(*b*) Extra Set on Contract of June 15, 1891.

This extra set of 10-inch forgings was due March 1, 1896. The time was extended to March 11, 1896. The set was delivered March 21, 1896, with a penalty of $100 deducted for 10 days' delay. The 10-inch forgings were shipped to Watervliet Arsenal, West Troy, N. Y.

III.—8-INCH B. L. RIFLE, MODEL 1888 M_{II}.

This contract, dated June 12, 1895, was for 4 sets of forgings. The contract expired on December 29, 1895. The final delivery was made on December 27, 1895. Five days' penalty was deducted on the first set, for delay in delivery. The forgings were shipped to Watervliet Arsenal, West Troy, N. Y.

IV.—5-INCH RAPID-FIRE GUN.

This gun was made under contract dated April 6, 1896, which expired June 8, 1896. The forgings were finished and shipped to Watervliet Arsenal, West Troy, N. Y., on May 20, 1896.

V.—3.6-INCH B. L. R. FIELD MORTARS.

Ten sets of forgings for these pieces were called for in contract dated June 17, 1895, expiring October 18, 1895. The entire number of forgings was completed and delivered October 1, 1895. The forgings were shipped to Watervliet Arsenal, West Troy, N. Y.

VI.—MISCELLANEOUS GUN FORGINGS.

(*a*) For 3.2-inch B. L. Rifle.

Twenty-five forgings, viz, 5 breechblocks, 5 spindles, 5 block carriers, and 10 gas checks were called for on an order dated October 2, 1895. All were completed and shipped October 22, 1895.

(*b*) For 3.2-inch Gerdom B. L. Rifle.

One block carrier was ordered for this gun January 16, 1896, and was shipped as soon as completed.

(c) FOR 4.7-INCH GERDOM B. L. GUN.

Five steel forgings, viz, 1 breech piece, 1 breechblock, 1 face plate, 1 block carrier, and 1 extractor, were ordered for this gun on January 10, 1896. The breech piece was shipped to Watervliet Arsenal, and the other pieces to Sandy Hook, N. J.

VII.—12-INCH DECK-PIERCING MORTAR SHELL.

The contract for 155 12-inch deck-piercing shell was dated June 17, 1895, and expired January 8, 1896. All the shell were completed and tested by December 12, 1895. The Midvale Steel Company sustained their reputation for making a high grade product by not failing in a single instance in the ballistic tests.

VIII.—10-INCH ARMOR-PIERCING SHOT.

This contract for 104 10-inch A. P. shot was dated June 17, 1895, and expired October 15, 1895. The shot were forged and undergoing treatment at date of last report. The projectiles were completed, and submitted for ballistic test on September 13, 1895. The usual success attended the tests of the two lots of 10-inch A. P. shot, and they were delivered September 26, 1896. The 6 extra shot were accepted under the provisions of the contract, making 110 shot in all.

IX.—8-INCH TEMPERED-STEEL SHELL, MODEL 1896.

Twenty tempered-steel shell were made under the contract dated April 29, 1896, expiring June 10, 1896. The shell were treated and submitted for ballistic test May 27, 1896. The whole lot was finish-machined and shipped to Sandy Hook, N. J., June 13, 1896.

X.—STEEL DECK PLATES.

There were six extra deck plates 4 feet and 6 inches square by 4½ inches thick ordered under the provisions of contract dated November 13, 1894. They were in all respects similar in treatment and quality to those reported last year. The plates were shipped to Sandy Hook, N. J., on February 4, 1895.

XI.—MISCELLANEOUS STEEL FORGINGS.

(a) BASE PLUGS FOR 7-INCH SHELL.

Three solid cylindrical forgings 27 inches long by 5$\frac{3}{16}$ inches in diameter were ordered for base plugs to accompany 30 steel castings for 7-inch shell. These forgings were ordered by the commanding officer, Watervliet Arsenal, August 6, 1896, and will be delivered early in September.

(b) STEEL BILLETS.

These billets were all made for Watervliet Arsenal. The details relating to number and size are given in the above list of fabrications:

RÉSUMÉ.

Billets from forged steel No. 1	20
Billets from forged steel No. 2	30
Billets from forged steel No. 3	253
Total	303

These billets are intended for forgings for gun carriages. Representative treatment has been resorted to in order to diminish the number of tests. In general special heats were made for the same purpose.

(c) STEEL FORGINGS FOR 10-INCH B. C. DISAPPEARING CARRIAGE FOR POND MACHINE TOOL COMPANY, PLAINFIELD, N. J.

The remainder of the 428 steel forgings due on this order were shipped during the latter part of the last calendar year.

XII.—STEEL CASTINGS.

(1) FOR 10-INCH BUFFINGTON-CROZIER DISAPPEARING CARRIAGE.

(*a*) *Order of Pond Machine Tool Company, Plainfield, N. J.* (*4 sets*).—Thirteen of the 160 steel castings comprising this order remained to be shipped subsequent to the date of last annual report. These have been completed and shipped, as well as some replacements of defective castings. The last piece was shipped February 29, 1896.

(*b*) *Contract with Watertown Arsenal* (*5 sets*).—There were 210 steel castings to be made under this contract. They were finished February 8, 1896.

(*c*) *Order of Kilby Manufacturing Company, Cleveland, Ohio.*—This company gave the Midvale Steel Company two orders for 10-inch chassis castings, viz, one order February 26, 1896, for 5 chassis (3 right and 2 left), and one June 17, 1896, for 2 chassis (both left hand), making 7 in all. All have been shipped to the Kilby Manufacturing Company. The last shipment was made July 29, 1896.

(2) FOR 30 OPEN-HEARTH STEEL CASTINGS FOR 7-INCH SHELL.

This order is from Watervliet Arsenal and specifies that the castings "must be sound, free from blowholes and other defects, and must satisfactorily stand after machining an interior strain or water pressure test of at least 120 pounds per square inch;" defective pieces to be replaced without cost to the United States. These 30 castings were made, annealed, rough bored, and shipped to Watervliet Arsenal August 28, 1896.

XIII.—OUTSIDE WORK.

All material made at points other than the Midvale Steel Works is classed as "outside work". The inspectors stationed here had charge of the inspection of material for the Ordnance Department, U. S. A., at the following steel works, viz, the William Cramp & Sons' Ship and Engine Building Company, Philadelphia, Pa.; the Chester and Eureka Steel Casting companies, Chester, Pa.; the Penn Steel Casting and Machine Company, Chester, Pa., and the American Steel Casting Company, Thurlow, Pa. All outside work this year was restricted to steel castings, except that done at the William Cramp & Sons' Ship and Engine Building Company's works. The details of these fabrications are given below and in the "list of fabrications" at the head of this report.

(1) WILLIAM CRAMP & SONS' SHIP AND ENGINE BUILDING COMPANY.

(*a*) *Two Buffington-Crozier disappearing carriages for 10-inch B. L. rifle.*—These two carriages were to be delivered by July 18, 1895, but were delayed by the difficulty in procuring the necessary steel castings from subcontractors. At date of last report it was estimated that the last carriage would be delivered early in October, 1895. The first carriage was shipped December 4, 1895, and the second December 14, 1895.

(*b*) *One Spiller pneumatic disappearing carriage for 10-inch B. L. rifle.*—The contract for this carriage was dated November 5, 1894, and the original date of expiration of contract was June 5, 1895. The carriage is not yet completed. Captain Borup reports that the company expect to complete it by September 30, 1896.

(*c*) *3.2-inch limited recoil field carriage* (*Driggs system*).—This carriage was made under contract dated October 21, 1895, which expired November 30, 1895. The carriage was completed, but not in accordance with the terms of the contract, the carriage being in excess of the prescribed weight. It was shipped to Sandy Hook, N. J., July 21, 1896, for builders' trial and information, but has not been accepted by the Department.

Capt. H. D. Borup, Ordnance Department, U. S. A., has had complete charge of the work on these four gun carriages.

(2) THE CHESTER STEEL CASTING COMPANY, CHESTER, PA.

The 22 hydraulic buffer cylinders remaining at date of last report on the Rock Island Arsenal order for 188 castings for siege carriages have been shipped to that arsenal, thus completing the order originally given to the Eureka Steel Casting Company, which went into the hands of a receiver before completing their contract.

(3) THE EUREKA STEEL CASTING COMPANY, CHESTER, PA.

This company made 2 cast-steel brackets (1 right and 1 left hand) for 15-inch barbette carriage for Watertown Arsenal.

(4) THE PENN STEEL CASTING AND MACHINE COMPANY, CHESTER, PA.

(*a*) *For 10-inch B. C. disappearing carriage.*—The contract for 5 sets of steel castings, 215 in number, for Watertown Arsenal and dated March 16, 1896, is rapidly approaching completion, and will be finished about September 30, 1896. All the castings are completed and shipped except 6 gun levers and 1 racer, the latter a replacement. Four of these 7 castings are ready for test. Four gun levers have been rejected on tests, 2 cap squares were rejected for defects, and 1 elevating band was rejected for having no tests left on the casting.

(*b*) *For 12-inch barbette carriage.*—This order was for 2 sets of steel castings for 12-inch barbette carriages, and was given March 27, 1896. There were 26 castings. All have been completed. The last piece was shipped to Watertown Arsenal July 23, 1896.

(*c*) *12-inch barbette carriages.*—Sixteen cast-steel truck-wheel plates were ordered for these carriages on May 20, 1896, all of which were completed and shipped to Watertown Arsenal on June 20, 1896.

(5) THE AMERICAN STEEL CASTING COMPANY, THURLOW, PA.

(*a*) *For 12-inch gun-lift carriage.*—Of the 7 steel castings required for the above carriage all but 1, a top carriage had been shipped at the date of the last report. The first two castings for this top carriage were condemned and the third proved acceptable, and was shipped to Watertown Arsenal in November, 1895, thus completing the order.

(*b*) *For 10-inch B. C. disappearing carriage.*—There were 4 sets, making 160 steel castings ordered by the Pond Machine Tool Company of

Plainfield, N. J., in November, 1895. The entire order was completed and the last piece shipped February 29, 1896.

(*c*) *For 12-inch disappearing carriage.*—The contract of June 16, 1896, expiring September 14, 1896, calls for 1 set, consisting of 30 steel castings, to be made for Watertown Arsenal. Of these castings 18 have been shipped. All will be cast at expiration of contract, but can not be treated and tested much before the end of September, 1896. One top carriage has been lost by having a defective core in the mold.

(*d*) *For 12-inch barbette carriages.*—Under contract dated July 1, 1896, 26 steel castings, constituting 2 sets, are to be made for Watertown Arsenal. Four pieces have been shipped and 8 submitted for test. The larger castings will follow close upon those for the 12-inch disappearing carriage.

(*e*) *For 8-inch disappearing carriages.*—Five sets of castings for these carriages were contracted for by the commanding officer, Watertown Arsenal, on July 1, 1896. The date of expiration of contract is October 27, 1896. There are 140 castings in the lot, of which 74 have been shipped. The company expect to complete the order, except the chassis, this month.

XIV.—PHYSICAL TESTS.

To give a condensed statement of the physical properties of the steel forgings and steel castings, Tables A, B, C, D; E, F, G, and H, given below, have been prepared. In these tables the columns headed "Mean" are the arithmetical means of all specimens tested. The columns headed "Maximum" and "Minimum" give the highest and lowest results in each particular, taken separately, found in the whole series of bars tested. The object of these two headings is to show the extreme range in each particular, viz, tensile strength, elastic limit, elongation, and contraction of area. Though some of the specimens show abnormal results, due to defects in the bar, which were known to the inspector before testing, all such have been included in getting the arithmetical means, and reduce the results somewhat.

Tables F, G, and H give the comparative results of different years for principal parts of 12-inch, 10-inch, and 8-inch gun forgings.

Table E gives a résumé of the results obtained from steel castings made by three different companies.

Table I gives the aggregate weights of steel castings and steel forgings shipped since the date of last report.

Table K shows the number of forgings and castings shipped and the total number of specimens that have been tested.

These tables have been prepared by my assistant, Mr. O. W. Albee, M. E., who has been in charge of the work at the works of the Penn Steel Casting Company and of the American Steel Casting Company.

Recapitulation of maximum, mean, and minimum of tensile tests.

TABLE A.—PARTS OF 12-INCH B. L. RIFLE.

Name of piece.	Tested.		Maximum.				Mean.				Minimum.			
	No. of pieces.	No. of bars.	Elastic limit.	Tensile strength.	Elongation.	Contraction of area.	Elastic limit.	Tensile strength.	Elongation.	Contraction of area.	Elastic limit.	Tensile strength.	Elongation.	Contraction of area.
			Pounds per sq. in.	*Pounds per sq. in.*	*Per cent.*	*Per cent.*	*Pounds per sq. in.*	*Pounds per sq. in.*	*Per cent.*	*Per cent.*	*Pounds per sq. in.*	*Pounds per sq. in.*	*Per cent.*	*Per cent.*
Tubes	5	30	51,000	97,200	24.60	59.30	46,300	86,170	21.13	39.12	41,000	80,000	16.80	21.40
Jackets	5	40	55,000	102,400	24.20	52.40	51,150	93,410	21.45	43.00	45,000	84,800	17.00	20.40
Trunnion hoops	5	20	58,000	101,600	22.90	56.50	54,920	98,800	19.35	48.37	50,000	95,600	15.30	29.70
Hoops:														
A_1	3	9	58,000	102,800	22.10	54.80	54,777	96,430	18.81	49.77	51,000	93,400	16.60	44.50
A_2	5	30	62,000	105,600	20.00	56.30	56,700	99,110	16.95	41.72	52,000	94,000	12.60	25.76
A_3	5	30	62,000	108,000	22.20	53.60	57,400	98,670	18.09	44.01	53,000	91,600	16.00	27.00
B_2	5	39	66,000	109,600	22.20	51.50	54,420	101,200	16.69	40.00	50,000	93,200	10.10	13.70
B_3	5	20	62,000	110,400	21.50	51.70	58,150	101,120	16.61	38.33	53,000	96,000	12.00	12.40
C_1	2	12	65,000	105,600	21.20	49.50	55,666	97,360	17.37	34.45	51,000	93,400	14.30	24.20
C_2	4	24	63,000	105,200	22.00	50.00	56,500	98,150	18.22	39.92	53,000	93.200	16.10	18.20
C_3	3	9	64.000	108,400	21.60	51.90	54,111	99,600	20.66	48.64	53,000	98,800	19.20	43.20
D	5	30	69,000	108,800	21.00	54.40	58,180	100,480	16.62	40.94	53,000	95,200	13.00	20.50
Breechblocks	2	2	54,000	100,400	18.70	42.20	53,000	100,000	18.55	38.40	52,000	99,600	18.40	34.60

TABLE B.—PARTS OF 10-INCH B. L. RIFLE.

Tubes	3	18	56,000	93,200	24.00	52.20	46,420	83,861	21.82	35.20	41,000	80,000	17.10	20.50
Jackets	5	30	61,000	99,600	23.80	53.40	49,930	90,580	21.09	41.58	47,000	85,400	18.00	22.70
Trunnion hoops	3	9	62,000	109,600	21.10	51.70	58,333	104,090	17.16	39.93	53,000	96,400	14.80	32.02
Hoops:														
A_1	3	9	63,000	108,000	18.70	42.40	58,000	102,840	15.00	30.20	53,000	96,800	12.00	13.40
A_2	2	6	64,000	110,000	19.20	48.40	60,166	104,000	16.05	37.10	54,000	96,800	12.50	19.50
A_3	2	12	59,000	103,600	19.30	54.40	55,333	99,500	15.80	36.72	53,000	94,800	12.50	22.30
B_2	2	6	64,000	108,400	18.30	45.90	59,500	102,030	16.70	38.90	55,000	94,400	14.00	34.10
B_3	2	6	60,000	105,200	19.90	51.50	56,167	100,070	16.70	36.30	52,000	93,600	13.90	27.00
C_1	3	18	60,000	102,800	21.80	46.60	54,111	98,894	17.56	34.55	50,000	96,000	15.00	22.30
C_2	3	18	63,000	104,000	21.40	47.40	56,780	99,500	18.80	38.55	52,000	93,800	14.70	27.30
D	3	18	59,000	110,000	20.30	43.80	55,833	100,555	16.60	31.30	52,000	96,000	13.00	16.90
Gas checks	1	2	82,000	144,800	12.00	28.20	81,500	144,700	11.60	25.10	81,000	144.000	11.20	22.00
Breechblocks	3	3	54,000	96,800	26.20	51.00	50,700	94,400	23.70	48.93	46,000	89,600	22.00	46.60
Spindles	2	2	56,000	96,200	23.20	49.70	54,000	95,700	22.90	47.30	52,000	95,200	22.30	44.80

TABLE C.—EIGHT-INCH B. L. RIFLE.

Tubes	4	24	55,000	94,400	23.20	45.10	44,200	87,540	20.12	39.33	42,000	80,800	16.20	30.00
Jackets	4	24	54,000	96,800	24.40	51.70	50,333	89,800	20.67	42.70	46,000	85,200	17.30	27.30
Trunnion hoops	4	12	56,000	97,200	22.60	58.80	52,300	95,184	20.53	50.70	49,000	92,800	18.70	40.80
Hoops:														
A_1	1	6	58,000	103,200	17.20	40.00	54,333	99,683	14.70	27.35	53,000	93,680	12.10	21.40
A_3	4	12	64,000	105,400	20.40	43.20	57,666	101,800	17.52	34.63	51,000	98,400	14.50	25.10
A_4	4	12	62,000	106,800	21.00	41.90	58,500	101,300	17.86	34.52	54,000	99,200	16.10	24.20
C_1	4	24	64,000	108,000	22.20	50.20	56,750	99,000	18.10	38.10	51,000	93,200	15.20	23.00
C_2	4	12	58,000	108,200	19.70	41.90	54,750	98,150	18.00	34.22	51,000	93,600	15.30	28.80
D	4	12	59,000	106,400	21.00	41.90	55,420	99,666	16.70	30.22	50,000	94,000	14.80	19.20
Breech bushing rings	2	4	59,000	106,500	21.60	40.30	57,000	103,125	22.30	34.50	54,000	98,500	18.00	30.20
Breechblocks	2	2	52,000	96,000	28.80	33.80	51,500	96,000	18.35	30.50	51,000	96,000	17.90	27.30
Spindles	3	3	54,000	97,500	24.30	48.60	53,000	97,000	22.03	39.40	52,000	96,500	19.50	30.50
Shoulder rings	1	3	64,000	105,200	20.00	48.40	62,700	104,700	19.67	45.57	61.000	103,600	19.00	42.20

TABLE D.

5-INCH R. F. GUN.

Tube	1	4	48,000	87,000	26.50	45.70	46,500	86,000	24.60	43.20	46,000	85,000	23.60	40.00
Jacket	1	5	58,000	98,800	21.50	44.50	54,800	97,240	18.88	35.80	50,000	94,400	17.20	27.30
Breechblock	1	1	60,000	105,000	21.70	44.90	60,000	105,000	21.70	44.90	60,000	105,000	21.70	44.90

3.6-INCH B. L. R. FIELD MORTARS.

Body	10	10	54,000	104,000	28.20	47.80	50,700	94,640	22.51	37.58	46,000	86,250	20.50	30.90
Breechblocks	2	2	56,000	99,000	19.20	41.00	55,500	98,000	18.50	39.60	55,000	97,000	17.80	38.20
Spindles	2	2	59,500	95,500	26.40	55.70	54,750	93,500	25.35	55.45	50,000	91,500	24.30	55.20
Gas checks	3	3	78,000	132,500	17.50	41.00	77,000	131,250	16.70	40.37	76,000	130,500	16.00	39.10

BILLETS—STEEL FORGINGS.

Steel, No. 2	2	2	44,500	75,000	34.20	56.30	42,000	73,750	32.85	54.40	39,500	72,500	31.50	52.50
Steel, No. 3	17	17	62,250	109,000	26.60	48.30	55,530	102,700	19.55	33.66	42,500	95,000	15.00	19.90

DECK PLATES.

Deck plates	6	12	53,500	92,500	30.40	58.60	49,800	89,350	26.55	52.58	41,000	83,500	22.80	40.30

TABLE E.

STEEL CASTINGS MADE BY MIDVALE STEEL COMPANY.

Name of piece.	Tested.		Maximum.				Mean.				Minimum.			
	No. of pieces.	No. of bars.	Elastic limit.	Tensile strength.	Elongation.	Contraction of area.	Elastic limit.	Tensile strength.	Elongation.	Contraction of area.	Elastic limit.	Tensile strength.	Elongation.	Contraction of area.
			Pounds per sq. in.	*Pounds per sq. in.*	*Per cent.*	*Per cent.*	*Pounds per sq. in.*	*Pounds per sq. in.*	*Per cent.*	*Per cent.*	*Pounds per sq. in.*	*Pounds per sq. in.*	*Per cent.*	*Per cent.*
Steel, No. 1, Buffington-Crozier carriage	112	191	41,500	78,000	37.60	64.00	32,524	67,210	28.92	44.65	24,500	58,500	12.00	13.00
Steel, No. 2, Buffington-Crozier carriage	12	12	39,250	81,500	29.20	38.20	36,000	77,000	22.80	31.15	30.500	70,800	18.80	23.40
Gun levers	10	30	38.500	76,000	37.20	61.80	32,947	67,940	31.66	48.51	28,000	60,000	28.00	41.00
STEEL CASTINGS MADE BY AMERICAN STEEL CASTING COMPANY, THURLOW, PA.														
Steel, No. 1, 12-inch gun lift	1	3	35,500	82,000	27.80	47.80	31,830	69,333	24.00	37.70	30,000	63,000	17.40	20.60
10-inch Buffington-Crozier carriage	61	94	39,000	77,500	35.20	56.00	31,600	68,330	28.35	40.61	26,000	59,500	15.00	23.80
Gun levers	8	24	35,000	75,500	31.60	54.10	31,100	68,050	29.15	47.76	29,000	60,500	24.80	41.00
Steel, No. 2, 10-inch Buffington-Crozier carriage	8	8	36,000	75,500	29.50	40.30	33,940	73,750	25.70	36.47	31,000	68,000	22.00	27.90
STEEL CASTINGS MADE BY THE PENN STEEL CASTING AND MACHINE COMPANY, CHESTER, PA.														
Steel, No. 1, 12-inch barbette	9	21	33,500	75,500	34.40	61.80	32,250	70,000	25.67	37.23	28,000	58,500	18.30	21.00
10-inch Buffington-Crozier carriage	71	106	37,500	84,000	29.40	46.40	32,351	68,753	21.35	28.60	30,000	62,500	11.60	15.60
15-inch truck-wheel plates	4	4	33,000	67,000	21.50	42.50	31,500	64,825	22.70	32.70	30,500	61,800	16.50	23.40
Steel, No. 2, 12-inch barbette	2	6	35,000	73,000	28.60	39.40	32,333	71,292	24.20	33.73	31,000	69,250	16.50	21.70
10-inch Buffington-Crozier carriage	10	10	38,000	82,500	21.80	30.20	35,750	77,250	20.20	25.23	32,500	73,500	15.80	23.10

TABLE F.—*Comparative table of results of tensile tests.*

12-INCH B. L. RIFLE.

Name of piece.	Year.	Tested.		Mean.			
		No. of pieces.	No. of bars.	Elastic limit.	Tensile strength.	Elongation.	Contraction of area.
				Pounds per sq. in.	*Pounds per sq. in.*	*Per cent.*	*Per cent.*
Tubes	1895	6	39	46,820	83,600	22.18	42.48
	1896	5	30	46,300	86,170	21.13	39.12
Jackets	1895	6	48	50,145	89,395	21.18	42.37
	1896	5	40	51,150	98,410	21.45	43
Trunnion hoops	1895	6	24	54,833	98,000	20.10	49.54
	1896	5	20	54,920	98,800	19.85	48.37
Hoops:							
A_1	1895	8	24	56,042	99,354	17.57	44
	1896	3	9	54,777	96,430	18.81	49.77
A_2	1895	6	18	57,000	99,400	19.06	42.85
	1896	5	30	56,700	99,110	16.95	41.72
A_3	1895	6	36	56,444	95,690	17.26	45.80
	1896	5	30	57,400	98,670	18.09	44.01
B_1	1895	6	49	55,700	97,940	15.80	37.13
	1896	5	39	54,420	101,200	16.69	40
B_2	1895	6	26	57,577	101,735	16.28	38.76
	1896	5	20	58,150	101,120	16.61	38.33
C_1	1895	9	54	56,666	98,960	18.76	37.80
	1896	2	12	55,666	97,360	17.37	34.45
C_2	1895	7	44	56,932	99,382	18.32	39.15
	1896	4	24	56,500	96,150	18.22	39.92
C_3	1895	6	18	58,944	103,444	19.70	45.33
	1896	3	9	54,111	99,600	20.66	48.64
D	1895	6	37	58,135	101,108	16.16	40.64
	1896	5	30	58,130	100,480	16.62	40.94

TABLE G.—*Comparative table of results of tensile tests.*

10-INCH B. L. RIFLE.

Name of piece.	Year.	Tested.		Mean.			
		No. of pieces.	No. of bars.	Elastic limit.	Tensile strength.	Elongation.	Contraction of area.
				Pounds per sq. in.	*Pounds per sq. in.*	*Per cent.*	*Per cent.*
Tubes	1894	12	72	45,614	82,406	21.65	39.80
	1895	4	26	46,038	84,462	20.78	40.16
	1896	3	18	46,420	83,861	21.32	35.20
Jackets	1894	14	84	48,990	88,352	20.44	39.04
	1895	4	24	50,050	91,135	20.73	42.72
	1896	5	30	49,930	90,580	21.09	41.58
Trunnion hoops	1894	11	33	56,940	98,551	18.70	48.24
	1895	4	12	57,333	101,367	19.24	49.55
	1896	3	9	58,333	104,090	17.16	39.93
Hoops:							
A_1	1894	6	17	55,000	98,130	16.85	33.80
	1895	3	9	56,444	98,533	16.80	40.31
	1896	3	9	58,000	102,840	15	30.20
A_2	1894	5	15	53,733	97,833	16.54	40.99
	1895	5	15	55,133	101,192	16.55	38.43
	1896	2	6	60,166	104,000	16.05	37.10
A_3	1894	7	21	56,000	100,105	15.71	36.07
	1895	4	24	57,500	101,383	16.40	36.20
	1896	2	12	55,333	99,500	15.80	36.72
B_1	1894	8	24	57,000	100,640	15.42	34.10
	1895	4	12	55,250	97,970	15.90	31.54
	1896	2	6	59,500	102,030	16.70	38.90
B_2	1894	6	18	56,300	101,411	15.63	33.60
	1895	4	12	56,417	100,533	17.11	38.63
	1896	2	6	56,167	100,070	16.70	36.30
C_1	1894	12	36	54,700	97,309	17.74	35.04
	1895	3	18	55,444	99,393	18.70	38
	1896	3	18	54,111	98,894	17.56	34.55
C_2	1894	12	36	57,194	98,733	17.19	35.92
	1895	3	18	55,722	100,766	17.54	34
	1896	3	18	56,780	99,500	18.30	38.55
D	1894	12	36	55,306	98,725	17.65	32.77
	1895	3	19	56,120	99,432	18.14	36.76
	1896	3	18	55,833	100,555	16.60	31.30

TABLE H.—*Comparative table of results of tensile tests.*

8-INCH B. L. RIFLE.

Name of piece.	Year.	Tested.		Mean.			
		No. of pieces.	No. of bars.	Elastic limit.	Tensile strength.	Elongation.	Contraction of area.
				Pounds per sq. in.	*Pounds per sq. in.*	*Per cent.*	*Per cent.*
Tubes	1894	9	53	46,434	83,081	21.21	41.46
	1896	4	24	44,200	87,540	20.12	39.33
Jackets	1894	9	54	51,333	89,485	20.46	41.12
	1896	4	24	50,333	89,800	20.67	42.70
Trunnion hoops	1894	10	30	54,600	97,093	19.26	49.66
	1896	4	12	52,300	95,184	20.53	50.70
Hoops:							
A_1	1894	5	15	55,600	96,653	19	38.91
	1896	1	6	54,333	99,683	14.70	27.35
A_2	1894	9	27	55,900	99,888	18.73	37.77
A_3	1896	4	12	57,666	101,800	17.52	34.63
A_4	1894	9	28	57,358	99,000	17.62	34.43
	1896	4	12	58,500	101,300	17.86	34.52
C_1	1894	9	27	58,240	98,244	17.88	38
	1896	4	24	56,750	99,000	18.10	38.10
C_2	1894	10	30	56,900	99,153	18.26	38.46
	1896	4	12	54,750	98,150	18	34.22
D	1894	9	27	56,408	95,350	17.47	35.11
	1896	4	12	55,420	99,666	16.70	30.22

TABLE I.

WEIGHTS OF STEEL CASTINGS.

Designation.	Shipped from—	Aggregate weight.
		Pounds.
12-inch barbette	Penn Steel Casting and Machine Co., Chester, Pa.	118,050
12-inch gun lift	American Steel Casting Co., Thurlow, Pa.	24,000
12-inch Buffington-Crozier	.....do	52,573
10-inch Buffington-Crozier	.....do	261,123
Do	Penn Steel Casting and Machine Co., Chester, Pa.	304,772
Do	Midvale Steel Works	526,208
8-inch Buffington-Crozier	American Steel Casting Co., Thurlow, Pa.	15,839
15-inch truck-wheel plates	Penn Steel Casting and Machine Co., Chester, Pa.	2,343
15-inch brackets	Eureka Cast Steel Co., Chester, Pa.	2,023
Total		1,306,431

WEIGHTS OF FORGINGS—MIDVALE.

Designation.	Aggregate weight.
	Pounds.
12-inch B. L. rifle	698,617
10-inch B. L. rifle	177,642
8-inch B. L. rifle	156,856
5-inch B. L. rifle	10,241
4.7-inch B. L. rifle	1,396
3.6-inch B. L. R. mortars	3,214
10-inch A. P. shot	62,810
12-inch D. P. shell	118,110
8-inch D. P. shell	5,450
Miscellaneous	436,373
Total	1,670,709

TABLE K.

Midvale Steel Works:	
Number of forgings shipped from Midvale Steel Works	1,368
Number of castings shipped from Midvale Steel Works	308
Outside works:	
Number of castings shipped from American Steel Casting Company, Thurlow, Pa	351
Number of castings shipped from Penn Steel Casting and Machine Company, Chester, Pa	251
Number of castings shipped from Eureka Cast Steel Company, Chester, Pa	24
Total from all works	2,302
Total number of test bars broken at Midvale Steel Works	1,757

Respectfully submitted.

D. A. LYLE,
Captain, Ordnance Department, U. S. A., Inspector.

The CHIEF OF ORDNANCE, UNITED STATES ARMY,
Washington, D. C.

(10766)

APPENDIX 20.

PROGRESS REPORT ON THE MANUFACTURE OF STEEL FORGINGS, CASTINGS, ETC., AT THE BETHLEHEM IRON WORKS.

OFFICE OF INSPECTOR OF ORDNANCE, U. S. A.,
BETHLEHEM IRON WORKS,
South Bethlehem, Pa., November 5, 1896.

SIR: I have the honor to submit the following report of the progress during the fiscal year ending June 30, 1896, of the work ordered by the Ordnance Department to be made under the supervision of the inspector of ordnance at these works.

The Bethlehem Iron Company has been manufacturing forgings and castings under the following contracts or orders, viz:

(1) 2 sets of forgings for 12-inch B. L. rifle, contract of October 18, 1894.
(2) 6 sets of forgings for 7-inch B. L. mortars, contract of April 10, 1895.
(3) 4 sets of forgings for 10-inch B. L. rifle, contract of June 12, 1895.
(4) Breech mechanism forgings for Seabury 3.2-inch B. L. rifle, August 15, 1895.
(5) Breech mechanism forgings for Dashiell 3.2-inch B. L. rifle, August 15, 1895.
(6) Breech mechanism forgings for 12-inch B. L. mortar (Farcot-Fletcher), September 10 and November 11, 1895.
(7) Breech mechanism forgings for 12-inch B. L. rifle, model 1892, December 10, 1895.
(8) Castings for five 8-inch Buffington-Crozier disappearing carriages ordered by Watertown Arsenal December 22, 1894.
(9) Castings for six 7-inch B. L. mortar carriages ordered by Watertown Arsenal February 19, 1896.
(10) Miscellaneous forgings for rifles and gun carriages.

They have also been manufacturing:

(11) Four 10-inch Buffington-Crozier disappearing carriages, contract of January 8, 1895.
(12) 100 B. L. rifles, 8, 10, and 12 inch calibers, contract of November 7, 1891.

The Carpenter Steel Company have had to furnish the following projectiles:

(13) One hundred 12-inch armor-piercing projectiles, contract of August 7, 1893.
(14) Eighty-one 12-inch armor-piercing projectiles, contract of December 8, 1894.

(1) FORGINGS FOR 12-INCH B. L. RIFLES.

These forgings were all completed and delivered by August 24, 1895.

(2) FORGINGS FOR 7-INCH B. L. MORTARS.

Deliveries under this contract were completed by November 20, 1895, the last four sets being delayed by from 25 to 45 days beyond the prescribed times on account of failures with the mortar bodies.

(3) FORGINGS FOR 10-INCH B. L. RIFLES.

Deliveries under this contract were completed December 31, 1895.

(4 AND 5) FORGINGS FOR SEABURY AND DASHIELL BREECH MECHANISMS FOR 3.2-INCH B. L. RIFLES.

The first were delivered by October 25, 1895, and the second by November 12, 1895, a delay of 29 and 47 days, respectively.

(6 AND 7) FORGINGS FOR 12-INCH B. L. RIFLE BREECH MECHANISM.

The first of these were delivered December 31, 1895, and the second April 20, 1896, a delay of 22 and 49 days, respectively.

(8) 8-INCH DISAPPEARING-CARRIAGE CASTINGS.

The final delivery under this order was made on July 16, 1895, about 5 months after the expiration of the contract time.

(9) 7-INCH B. L. MORTAR-CARRIAGE CASTINGS.

Deliveries of these castings were completed by April 25, 1896.

(10) MISCELLANEOUS FORGINGS.

The deliveries of forgings for two 10-inch disappearing carriages made by the William Cramp & Sons Company were completed July 10, 1895. Those for 4 carriages made by the Pond Machine Tool Company were delivered by April 21, 1896, and those for 10 carriages made by the Kilby Manufacturing Company have been in part delivered.

Of 2 locking rings for 5-inch steel rifle, ordered by Watervliet Arsenal, the first was delivered December 17, 1895, being overdue 29 days; the second was due June 28, 1896, and was not delivered on June 30, 1896.

One 5-inch trunnion hoop, replacing, delivered December 17, 1895, overdue 62 days.
One 5-inch trunnion hoop, replacing, not delivered by June 30, 1896.
One 10-inch trunnion hoop, replacing, delivered June 26, 1896.
One 10-inch spindle, replacing, delivered January 16, 1896, overdue 26 days.
One tray casting for 12-inch B. L. mortar, due December 11, 1895, delivered March 3, 1896.

(11) 10-INCH DISAPPEARING CARRIAGES.

Long periods of delay occurred in the delivery of each of these carriages, due to some extent to the difficulty experienced in casting the large pieces of steel and to the novelty of manufacture. The first was delivered on December 19, 1895, the second on March 21, 1896, the third on June 25, 1896, and the fourth was almost completed June 30, 1896.

(12) 8, 10, AND 12 INCH B. L. STEEL RIFLES.

Up to June 30 there had been completed under this contract ten 8-inch and fifteen 10-inch rifles. There were in progress fifteen 8-inch, which will be completed before the end of the year, and ten 10-inch rifles, which have the tubes prepared for assembling the jackets and C hoops. There are also five 12-inch rifles under way, four of which have the jackets and C hoops assembled, the fifth tube being bored and turned for shrinkage. Forgings for a few additional 10 and 12 inch rifles are ready for assembling.

(13 AND 14) ARMOR-PIERCING PROJECTILES.

None of the deliveries under this contract have yet passed the required ballistic test.

The following table of the average physical qualities of specimens tested here during the last year show about the same conditions to have been attained as in the preceding year, and are not as satisfactory as should be expected from the experience gained in seven years of manufacture. The number of specimens tested was 1,510.

Designation of piece.	Number of pieces.	Elastic limit per square inch of original section.	Tensile strength per square inch of original section.	Elongation after rupture.	Reduction in area after rupture.
		Pounds.	*Pounds.*	*Per cent.*	*Per cent.*
8.2-inch lining tubes	2	61, 165	103, 890	23. 0	43. 1
8.2-inch breechblocks	2	51, 000	90, 250	22. 0	42. 2
3.2-inch block carrier	1	47, 000	86, 000	21. 5	34. 1
3.2-inch carrier ring	1	47, 000	83, 500	25. 5	44. 0
5-inch trunnion hoop	1	55, 250	104, 300	16. 6	32. 9
5-inch locking ring	1	59, 500	103, 750	20. 8	43. 1
7-inch mortar body	5	59, 910	92, 680	20. 1	40. 8
7-inch breechblocks	2	53, 000	91, 000	21. 5	40. 2
7-inch block carriers	2	40, 000	81, 000	24. 0	40. 6
7-inch spindles	2	49, 500	89. 250	27. 5	60. 5
7-inch gas-check cups	1	101, 000	180, 500	12. 0	28. 5
8-inch tube	1	48, 670	91, 930	19. 1	46. 0
8-inch jacket	1	51, 000	100, 760	17. 5	40. 4
8-inch trunnion hoop	1	54, 330	103, 070	15. 1	42. 8
8-inch C hoops	2	57, 500	105, 530	16. 2	35. 9
8-inch D hoops	1	56. 300	104, 130	18. 8	45. 0
8-inch breech bushing	1	55, 750	107, 750	19. 0	30. 6
8-inch breechblock	1	49, 000	93, 200	19. 1	35. 0
8-inch spindle	1	53, 000	95, 500	22. 5	46. 9
10-inch tubes	16	47, 555	88, 850	21. 4	46. 8
10-inch jackets	14	50, 860	94, 700	20. 4	47. 6
10-inch trunnion hoops	9	56, 810	107, 250	16. 8	44. 5
10-inch A hoops	35	58, 000	105. 500	16. 5	43. 1
10-inch B hoops	16	58, 820	107, 488	15. 7	41. 5
10-inch C hoops	28	57, 300	104, 320	18. 8	41. 8
10-inch D hoops	9	58, 870	107, 674	17. 4	40. 8
10-inch breechblocks	15	49, 133	94, 160	19. 1	36. 8
10-inch spindles	11	50, 818	93, 418	19. 6	43. 6
10-inch hinge pins	4	51, 500	97, 000	19. 9	49. 8
10-inch translating rollers	4	51, 750	97, 400	19. 9	46. 6
10-inch securing pins	5	82, 200	145, 560	13. 1	35. 5
10-inch gas-check cups	5	83, 500	150, 800	10. 8	26. 1
10-inch consoles	40	....	67, 740	32. 7	....
12-inch tubes	7	46, 953	95, 617	19. 6	39. 8
12-inch jackets	6	46, 697	96, 414	19. 0	37. 7
12-inch trunnion hoops	1	58, 250	108, 700	15. 8	39. 7
12-inch B hoops	1	56, 750	112, 300	14. 4	39. 0
12-inch C hoops	2	56, 167	104, 333	17. 9	40. 8
12-inch gas-check cups	1	96, 500	165, 000	11. 2	28. 8
12-inch hinge pins	1	46, 000	90, 000	23. 3	52. 4
12-inch tray	1	43, 000	71, 500	30. 5	51. 4
12-inch mortar bushing	1	57, 000	105, 200	18. 5	40. 4
12-inch mortar breechblock	1	49, 000	87, 400	23. 0	48. 3
12-inch mortar hinge pin	1	45, 000	84, 000	28. 5	59. 3
12-inch mortar hinge plate	1	44, 000	90, 400	19. 7	36. 0
12-inch mortar tray casting	1	38, 000	68, 500	32. 5	54. 4
Forged steel, No. 2	35	41, 286	78, 057	28. 2	50. 7
Forged steel, No. 3	172	53, 000	100, 984	19. 7	36. 3
Cast steel, No. 1	53	35, 710	68, 855	28. 3	45. 5
Gun iron	9	....	33, 000	....	....
Wrought iron	4	27, 250	48, 750	31. 9	44. 4
8-inch shot	....	....	31, 730	....	....
10-inch shot	....	....	29, 600	....	....

The weights of forgings shipped during the year are as follows:

Forgings for—	Weight.
	Pounds.
3.2-inch B. L. rifle	567
5-inch B. L. rifle	68
7-inch B. L. mortar	13, 266
7-inch B. L. mortar carriage	4, 629
10-inch B. L. rifle	331, 619
12-inch B. L. rifle	125, 349
12-inch B. L. mortar	2, 555
10-inch disappearing carriage	393, 150
Total	871, 203

Very respectfully, your obedient servant,

I. MACNUTT,
Captain, Ordnance Department, U. S. A., Inspector.

The CHIEF OF ORDNANCE, UNITED STATES ARMY,
Washington, D. C.

APPENDIX 21.

TRIAL OF ARMSTRONG 12-CM. (4.72-INCH) RAPID-FIRE GUN AND MOUNT.

(8 plates.)

THE ORDNANCE BOARD, U. S. A.,
NEW YORK ARSENAL,
GOVERNORS ISLAND, NEW YORK HARBOR,
New York City, April 6, 1896.

SIR: The following report of the test of an Armstrong 4.72-inch rapid-fire gun and mount is respectfully submitted:

DESCRIPTION.

THE GUN.

The gun is entirely of steel and consists of a tube over which is shrunk the jacket prolonged to the rear for the reception of the breechblock; three hoops shrunk over the tube in the prolongation of the jacket; a hoop shrunk over portions of the jacket and nearest hoop, securing them longitudinally by being screwed to the former and attached to the latter by a locking shoulder; and a breech ring for securing the gun to the recoil mechanism. The exterior of the jacket is furnished with longitudinal ribs which form guides for the gun when in its cradle. The chamber is conical.

The following table gives the principal dimensions with reference to the gun:

Caliber	inches	4.724
Weight	pounds	4,676
Length:		
Bore	inches	189
Rifling	do	171
Chamber	do	15.5
Total	do	194.1
Over all	do	205.1
Grooves		22

Rifling: Spiral, increasing from 1 turn in 100 calibers at breech to 1 turn in 34.4 calibers at 6.65 inches from the muzzle; the remainder 1 turn in 34.4 calibers.

BREECH MECHANISM.

The breech of the gun is closed by a block, C, formed in two steps, the front step being conical and the rear cylindrical. Both steps have three portions of their threads removed, each corresponding to one-sixth of a turn of the block, and having the threads on one portion opposite the blank spaces on the other. The interior of the gun is prepared for the

Record of firing with 4.72-inch Armstrong rapid-fire gun, No. 7346 (weight,

[Object of firing,

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Instrumental velocity 175 ft. from muzzle.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.			
1892. P. M.			*Lbs.* *Oz.*		*Lbs.* *Oz.*	° ′	*Feet.*	*Pounds.*
Sept. 28	1	Cordite.	3 0 1 igniter.	Common shell (steel), lot 347.	42 0 3 0 sand. 45 0	0 0		No. 4, 9, 110
Sept. 28	2		4 0 1 igniter.		42 0 3 0 sand. 45 0	2 0		
Sept. 28	3		5 8 1 igniter.		42 0 3 0 sand. 45 0	6 0		No. 4, 30, 636
Sept. 28	4		5 8 1 igniter.	Shrapnel, lot 348.	44 4 8 Elswick fuse set at 2.84″. 2 rifle powder, bursting charge. 44 14	3 30		
Sept. 28	5		5 8 1 igniter.	Case shot, lot 349.	45 0	1 0		
Sept. 28	6		5 8 1 igniter.		45 0	1 0		
Sept. 28	7		5 8 1 igniter.	Common shell (steel), lot 347.	42 0 3 0 sand. 45 0	12 0		
Sept. 28	8		5 8 1 igniter.		42 0 3 0 sand. 45 0	16 0		
Sept. 28	9		5 8 1 igniter.		42 8 2 8 sand. 45 0	20 0		
Sept. 28	10		5 8 1 igniter.		42 0 3 0 sand. 45 0	*Depression.* 4 0		
A. M. Sept. 29	11		5 8 1 igniter.		42 0 3 0 sand. 45 0	0 10	2, 195 2, 203	
Sept. 29	12		5 8 1 igniter.		42 0 8 0 sand. 45 0	0 0	2, 208 2, 210 $100+1\frac{1}{2}^{\circ}$	No. 4, 32, 480

4,676 pounds), at Sandy Hook Proving Ground, September 28 to October 14, 1892.

test of gun.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Inches.			
6¾	Wind from right and rear, 13 miles an hour; barometer, 30.10; thermometer, 76°; humidity, 55.	Electric primer used. Trigger pulled with lanyard. Slight escape of gas.	Gun mounted on automatic center pivot. Mounting on balance pillar. 9 pints of oil in cylinder. The training, elevating, raising, and lowering of the mounting tested. The electric firing apparatus tested by a sounding bell and by firing electric primer. The percussion firing apparatus tested by firing percussion primer. Test satisfactory, except in training it is a little tight in one spot, due to the close fit of one of the clips. The extreme vertical movement 38 inches. Handle of upper contact piece (which had been cracked in mounting) broken off while adjusting before firing. The priming charge in cartridge consisted of ¼ ounce rifle powder in puff and ¼ ounce in long primer. The puff occupied the bottom of the case, and the long primer the central portion of the charge. In rounds 6 to 10, inclusive, mount raised to full height. Copper cylinder of 9.000 pounds initial compression and tables of 1890 used in round 1. Copper cylinder of 18,000 pounds initial compression and tables of 1890 used in round 8.
6⅞		Electric primer used. Trigger pulled with lanyard. Slight leakage of oil at stuffing box of hydraulic cylinder; tightened up a little. Slight escape of gas.	
7¼		Electric primer used. Trigger pulled with lanyard. Slight leakage of oil at stuffing box of hydraulic cylinder. No escape of gas.	
7¼		Electric primer used. Fired from the shoulder. Shrapnel exploded in air. Slight escape of oil at stuffing box; tightened.	
7¼		Electric primer used. Fired from the shoulder. Case shot, containing 400 bullets, broke up.	
7¼		Electric primer used. Fired from the shoulder. Case shot containing 400 bullets. Shot broke up.	
7¼		Stuffing box tightened. Electric primer used. Cable caught around arm of breech collar and broke at its connection with lower contact piece.	
7¼		Percussion primer used..................	
7¼		Percussion primer used. Hole blown through primer, allowing gas to escape past the firing pin. The firing pin taken out and examined; head found broken off firing-pin insulator.	
7¼		....	
7¼	Wind from right and rear, 6 miles an hour; barometer, 30.43; thermometer, 65°; humidity, 56.	First primer failed. Distinct marks of firing pin on head. Second trial without cartridge primer exploded.	Percussion primers used. Fired to sea. Pressures and velocities taken by Lieut. F. P. Peck, Ordnance Department. Firing conducted by Lieut. F. P. Peck, Ordnance Department, in the presence of the Ordnance Board. Present: Maj. C. Comly, Ordnance Department; Capt. F. Heath, Ordnance Department; Capt. W. Crozier, Ordnance Department.
7¼		Copper cylinder of 32,000 pounds initial compression and tables of 1890.	

Record of firing with 4.72-inch Armstrong rapid-fire gun, No. 7346 (weight 4,676

[Object of firing,

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Instrumental velocity 175 ft. from muzzle.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.			
1892. P. M.			*Lbs. Oz.*		*Lbs. Oz.*			
Oct. 14	13	Cordite.	5 8 1 igniter.	Shrapnel, lot 348.	44 14 including fuze set at 3¼". 2 large-grain powder in bag. 45 0	....	....	....
Oct. 14	14		5 8 1 igniter.	Steel shell, lot 347.	41 8 shell. 1 10 pebble powder. 6 fine powder. 1 8 fuse and lead cap. 45 0	....	....	....

Record of firing with 4.72-inch Armstrong rapid-fire gun at Sandy

[Object of firing, exhibi

Date.	No of fire.	Powder.		Projectile.		Elevation.	Pressure per square inch of bore.	Counter recoil.
		Kind.	Weight.	Kind.	Weight.			
1893.			*Lbs. Oz.*		*Lbs. Oz.*	°	*Pounds.*	*Inches.*
July 21	15	Cordite.	2 0 1 igniter.	Common steel shell, lot 347.	45 0	....	....	5
July 21	16		5 8 1 igniter.	Case shot, lot 349.	45 0	....	....	7¼

[Object of firing, to test working

1894.								
Nov. 20	17	Cordite.	2 8 1 igniter.	Steel shell, lot 347.	45 0	....	5, 6,588	4¾
Nov. 20	18		5 8 1 igniter.		45 0	....	10, less than 32,000	7⅛

[Object of firing, exhibition before the

1894.								
Nov. 22	19	Cordite.	5 8 1 igniter.	Case shot, lot 349.	45 0	....	....	....
Nov. 22	20		5 8 1 igniter.	Shrapnel, lot 348.	45 0 2 bursting charge.	....	....	....
Nov. 22	21		5 8 1 igniter.	Steel shell, lot 347.	45 0 2 bursting charge.	1	....	....

pounds), at Sandy Hook Proving Ground, September 28 to October 14, 1892—Continued.

to test fuses.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
....	Wind from right and rear, 12 miles an hour; barometer, 30.25; thermometer, 69°; humidity, 55.	Fired to burst on graze at about 500 yards. Shrapnel exploded on striking.	Gun mounted on automatic center pivot. Mounting on balance pillar. Cylinder filled with oil. Electric primers used. Firing conducted by Lieut. F. P. Peck, Ordnance Department, in the presence of the Ordnance Board. Present: Maj. C. Comly, Ordnance Department; Capt. F. Heath, Ordnance Department; Capt. W. Crozier, Ordnance Department.
....		Fired to burst on striking at about 700 yards. Shell burst on striking.	

Hook Proving Ground, from July 21, 1893, to November 22, 1894.

tion before Senator Hawley.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
....	Electric primers used.
....	

of carriage and determine charge.]

¼ ounce rifle powder for ignition, on base ¼ ounce through center. Powder not entirely consumed.	Fired to sea.
Escape of gas around primer body.	

Board of Ordnance and Fortification.]

1 miss fire	Gun raised by 2 men in 20 seconds. Gun lowered by 2 men in 20 seconds. Fired to sea.
Time fuse set 0.83 second = 1 mile	
Percussion fuse; shell exploded	

Record of firing with 4.72-inch Armstrong rapid-fire

[Object of firing, exhibition before

Date.	No. of fire.	Powder.		Projectile.		Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.	
1895.			*Lbs. Oz.*		*Pounds.*	*Pounds.*
June 19	22	Cordite	5 0 1 igniter.	Common shell	45	25, 24,817
June 19	23	Cordite	5 0 1 igniter.	Common shell	45	10, 25,417
June 19	24	Cordite	5 0 1 igniter.	Common shell	45	20, 25,280

Record of firing with 4.72-inch Armstrong rapid-fire gun at

[Object of firing, to

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.		
1895. A. M.			*Lbs. Oz.*		*Pounds.*	°	*Pounds.*
July 17	25	Cordite	5 8 1 igniter.	Common shell	45	5	5, 30,455
July 17	26	Cordite	5 8 1 igniter.	Common shell	45	5	10, 29,277
July 17	27	Cordite	5 12 1 igniter.	Common shell	45	....	25, 32,709
July 17	28	Cordite	6 0 1 igniter.	Common shell	45	....	25, 36,222
uly 17	29	Cordite	6 0 1 igniter.	Common shell	45	....	25, 36,892
July 17	30	Cordite	6 0 1 igniter.	Common shell	45	....	25, 34,917

THE AMMUNITION.

(Plate VIII.)

The ammunition is metallic but not fixed, the projectile and powder charge being separate. The cartridge case has a pronounced conical shape. It is of solid drawn brass, provided with a screw hole in its head for the adapter or electrical primer, and a cap to cover its mouth. The powder charge is about 5½ pounds of cordite, and ignition is obtained by having a primer charge of black powder in the bottom of the case, and another occupying the central part of the powder charge. The projectiles are shrapnel, shell, and case shot, and weigh 45 pounds. The several dimensions of the ammunition are given in Pl. VIII. The description of the fuses is given in the report of the Chief of Ordnance for 1891.

The programme adopted for the test of 4.72-inch rapid-fire guns is as follows:

Each gun to be carefully examined by the board. The number of parts of the breech mechanism in each, their strength, simplicity, and certainty of action to be noted; also the ease, safety, and certainty of the breech mechanism as a whole. Note especially the action of the firing pin and extractor and the maximum outward position of the cartridge when it can be pushed home by the breechblock. During this examination 20 rounds to be fired at will from each gun.

VELOCITY.

Five rounds to be fired for velocity from each gun with full charges.

ACCURACY.

Ten rounds to be fired at each range of 1 mile and 3,000 yards, the same conditions of aiming being repeated at each round with the guns respectively, and the mean deviations determined.

RAPIDITY.

Determine the number of rounds that can be fired in 3 minutes, noting carefully during the firing, and especially at the termination of the test, the conditions of the gun as regards heat and ease and certainty of action.

Two detachments of men to be used, the first to be relieved in 1 minute 30 seconds. The above test to be repeated if found necessary by the board.

RAPIDITY WITH ACCURACY.

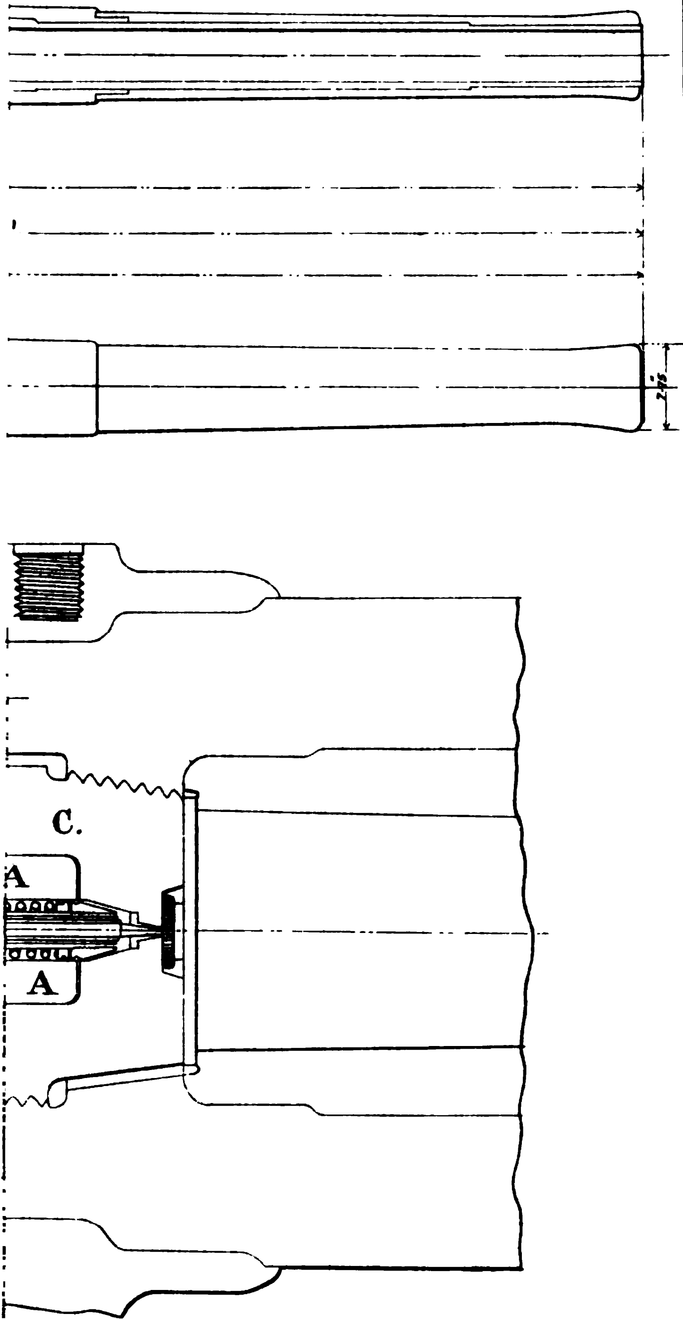
Fire 10 aimed shots as rapidly as possible at the 1,000-yard and 1-mile targets. Also 10 aimed shots at targets in same line and ranges of 500 yards and 1,000 yards alternately. Also 10 aimed shots alternately at targets at about 500 yards range, placed about 75 feet apart.

TEST OF SHRAPNEL.

Against steel plates.—Two shrapnel of each kind to be fitted with Frankford Arsenal sensitive-point fuses and fired to burst while passing through a screen placed in front of a 1¼-inch rolled-steel plate located about 150 feet from the gun; the effect on the plate of the fragments to be noted. The charge in above test to be such as to give a muzzle velocity equal to the remaining velocity at 1 mile when full charges are used.

For dispersion.—Three shrapnel of each kind to be fitted with Frankford Arsenal sensitive-point fuses and fired to burst while passing through a screen placed about 100 feet in front of the 1,000-yard target, and the number of hits and their character as regards penetration, etc., to be observed.

Plate I.



Appendix 21, 1896. Ord 54 2

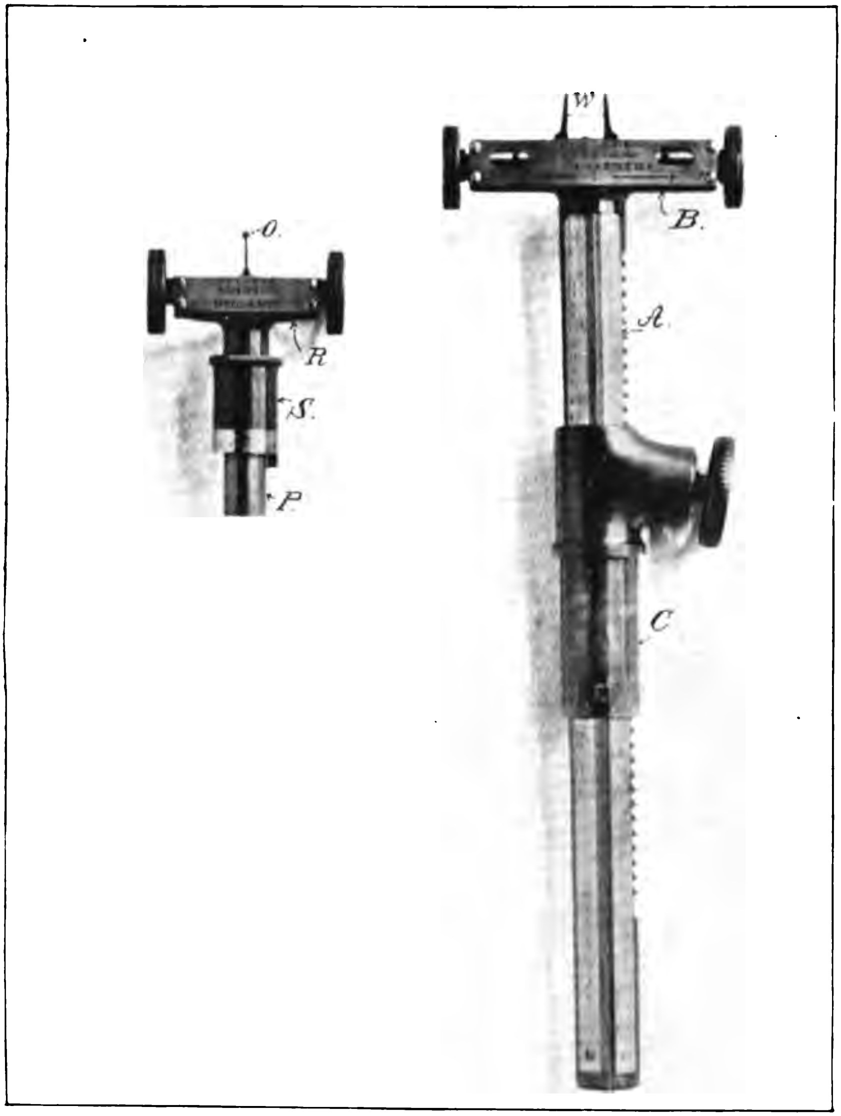
Range table for 4.72-inch Q. F. gun.

[Charge, 5½ pounds; projectile, 45 pounds; muzzle velocity, 640 meters (2,100 feet) per second.]

Range.	Elevation.	Time of flight.	Length of fuze.		Range.	Elevation.	Time of flight.	Length of fuze.	
			Medium.	Small.				Medium.	Small.*
Meters.	° ′	*Seconds.*	*Inches.*	*Inches.*	*Meters.*	° ′	*Seconds.*	*Inches.*	*Inches.*
100	0 3	0.15	....	....	3,600	4 49	8.72	3.73	....
200	0 6	.33	....	....	3,700	5 3	9.05	3.88	....
300	0 10	.51	....	....	3,800	5 17	9.38	4.03	....
400	0 14	.69	....	....	3,900	5 31	9.71	4.19	....
500	0 18	.86	....	0.41	4,000	5 45	10.05	4.35	....
600	0 23	1.04	....	.52	4,100	6 0	10.41	4.52	....
700	0 28	1.22	....	.63	4,200	6 16	10.77	4.69	....
800	0 33	1.40	....	.74	4,300	6 32	11.13	4.86	....
900	0 38	1.58	....	.85	4,400	6 48	11.50	....	....
1,000	0 43	1.77	....	.97	4,500	7 4	11.88	....	....
1,100	0 48	1.97	....	1.09	4,600	7 20	12.26	....	....
1,200	0 54	2.18	....	1.21	4,700	7 36	12.65	....	....
1,300	1 0	2.39	0.42	1.34	4,800	7 53	13.05	....	....
1,400	1 6	2.61	.50	1.47	4,900	8 10	13.45	....	....
1,500	1 12	2.84	.60	1.60	5,000	8 27	13.85	....	....
1,600	1 19	3.07	.71	1.73	5,100	8 45	14.26	....	....
1,700	1 26	3.31	.83	1.87	5,200	9 3	14.68	....	....
1,800	1 34	3.55	.96	2.00	5,300	9 21	15.10	....	....
1,900	1 42	3.80	1.11	2.13	5,400	9 40	15.53	....	....
2,000	1 51	4.05	1.26	2.27	5,500	10 0	15.96	....	....
2,100	2 0	4.31	1.42	2.40	5,600	10 19	16.39	....	....
2,200	2 9	4.57	1.58	2.53	5,700	10 38	16.83	....	....
2,300	2 18	4.83	1.74	2.67	5,800	10 57	17.27	....	....
2,400	2 28	5.10	1.90	2.80	5,900	11 17	17.71	....	....
2,500	2 38	5.37	2.06	2.93	6,000	11 37	18.16	....	....
2,600	2 48	5.65	2.22	3.06	6,100	11 57	18.61	....	....
2,700	2 58	5.94	2.38	3.20	6,200	12 18	19.07	....	....
2,800	3 9	6.23	2.53	3.34	6,300	12 39	19.54	....	....
2,900	3 21	6.53	2.68	3.48	6,400	13 0	20.01	....	....
3,000	3 33	6.83	2.83	3.62	6,500	13 21	20.48	....	....
3,100	3 45	7.13	2.98	3.76	6,600	13 42	20.95	....	....
3,200	3 57	7.44	3.13	3.91	6,700	14 4	21.43	....	....
3,300	4 10	7.76	3.28	4.06	6,800	14 26	21.91	....	....
3,400	4 23	8.08	3.43	4.21	6,900	14 48	22.39	....	....
3,500	4 36	8.40	3.58	....	7,000	15 10	22.87	....	....

* Small fuse used up to 3,400 meters.

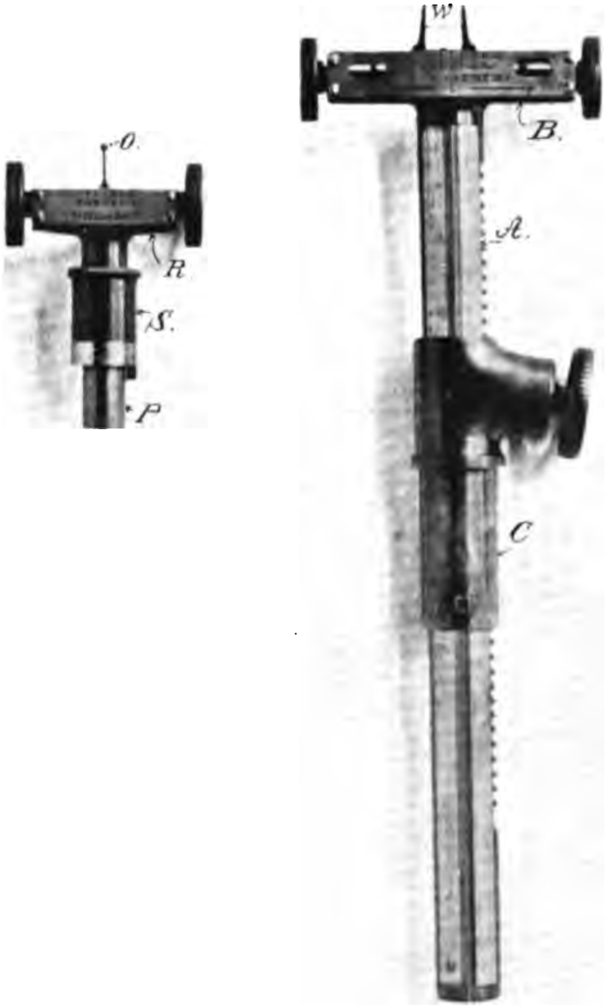
PLATE III.



Appendix 21, 1896.

SIGHTS. ARMSTRONG 4.7-INCH R. F. GUN.

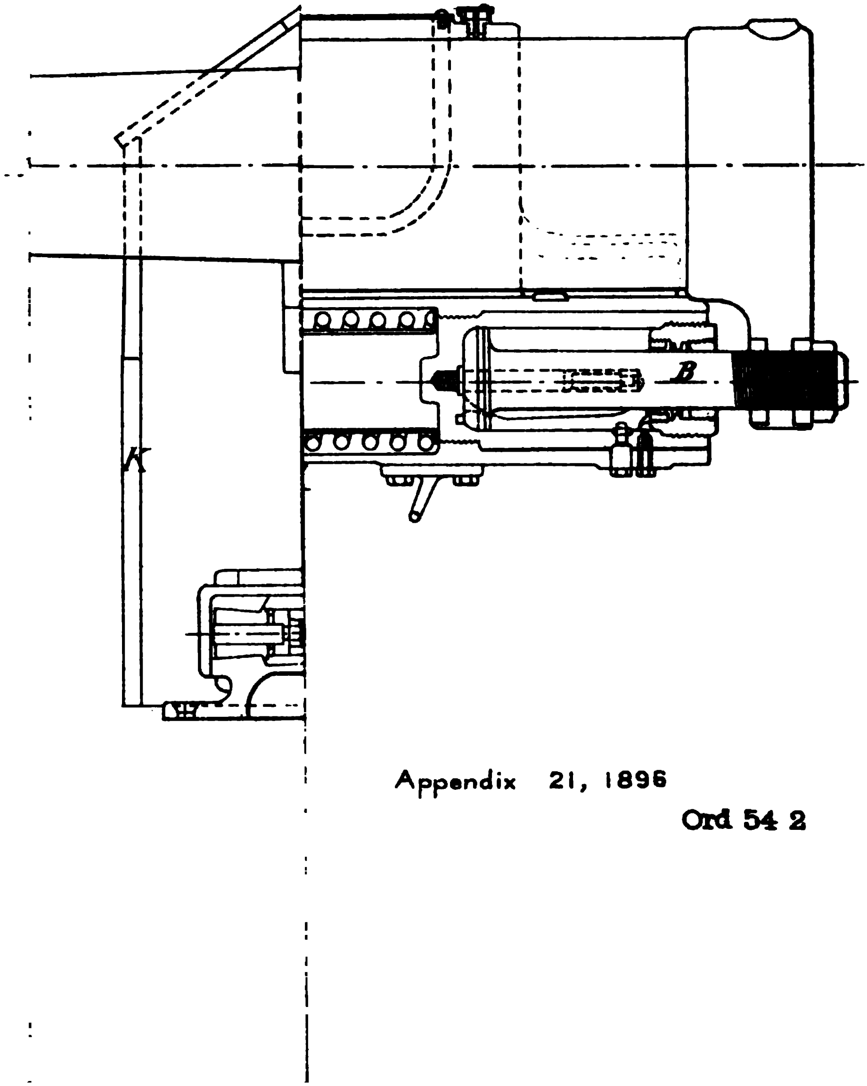
PLATE III.



Appendix 21, 1896.

SIGHTS. ARMSTRONG 4.7-INCH R. F. GUN.

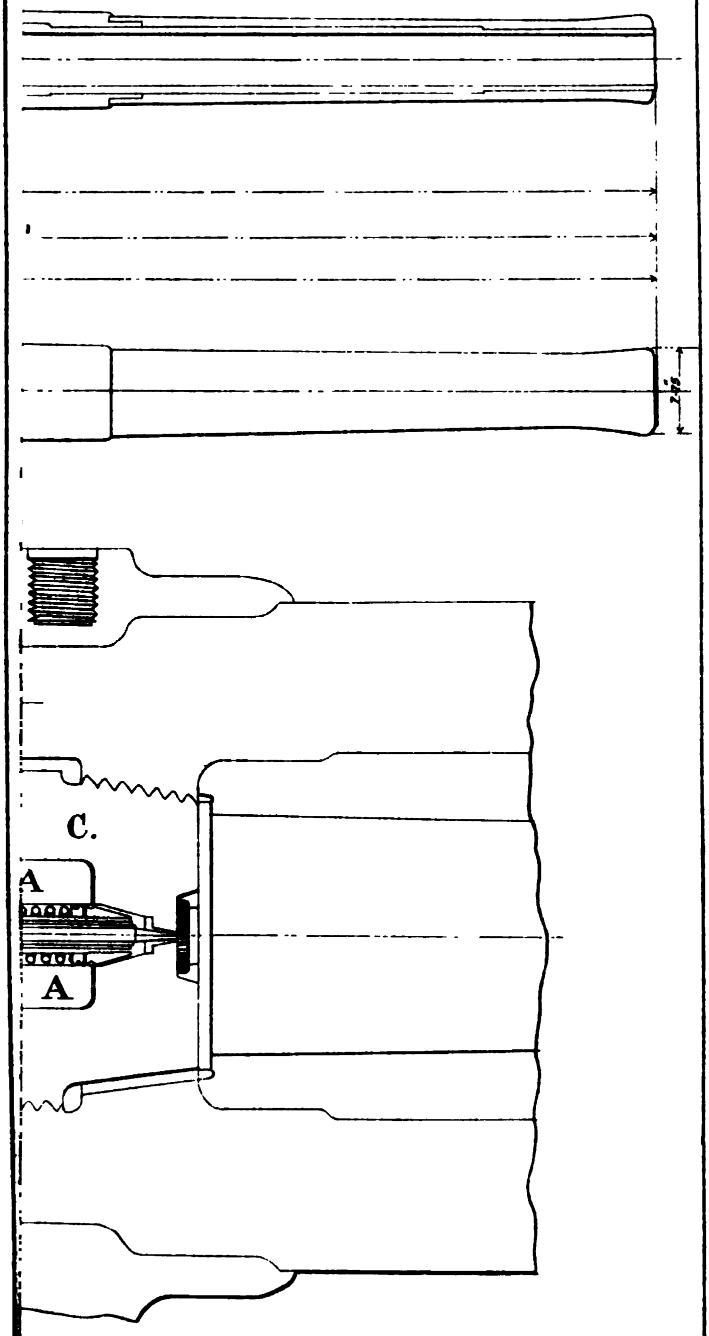
Plate IV.



Appendix 21, 1896

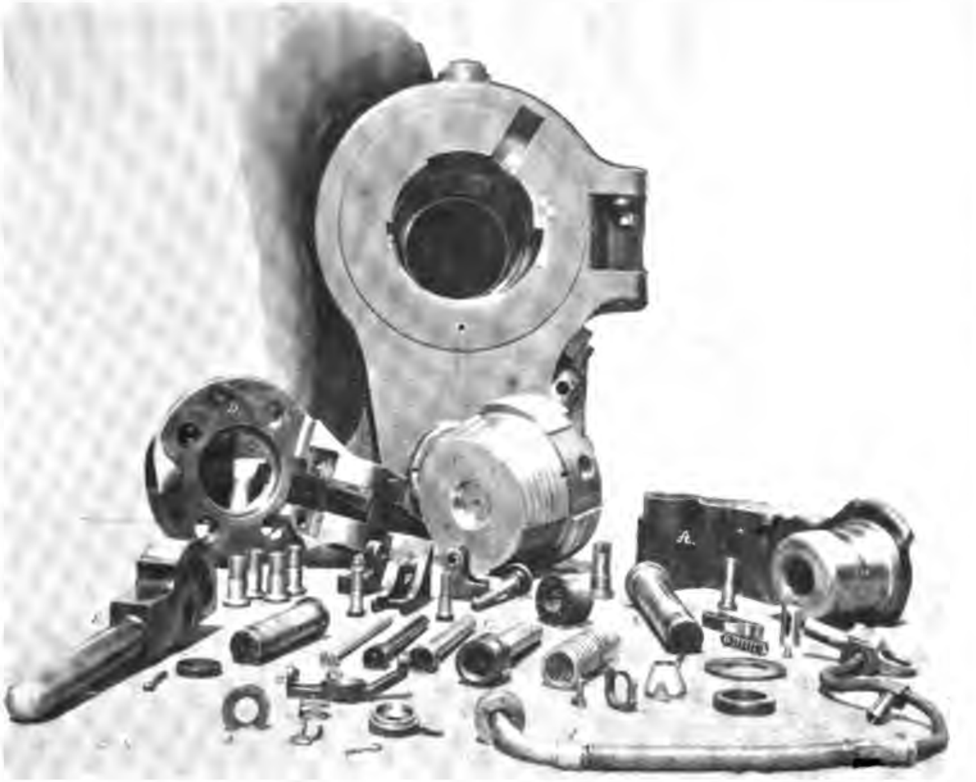
Ord 54 2

Plate I.



Appendix 21, 1896. Ord 54 2

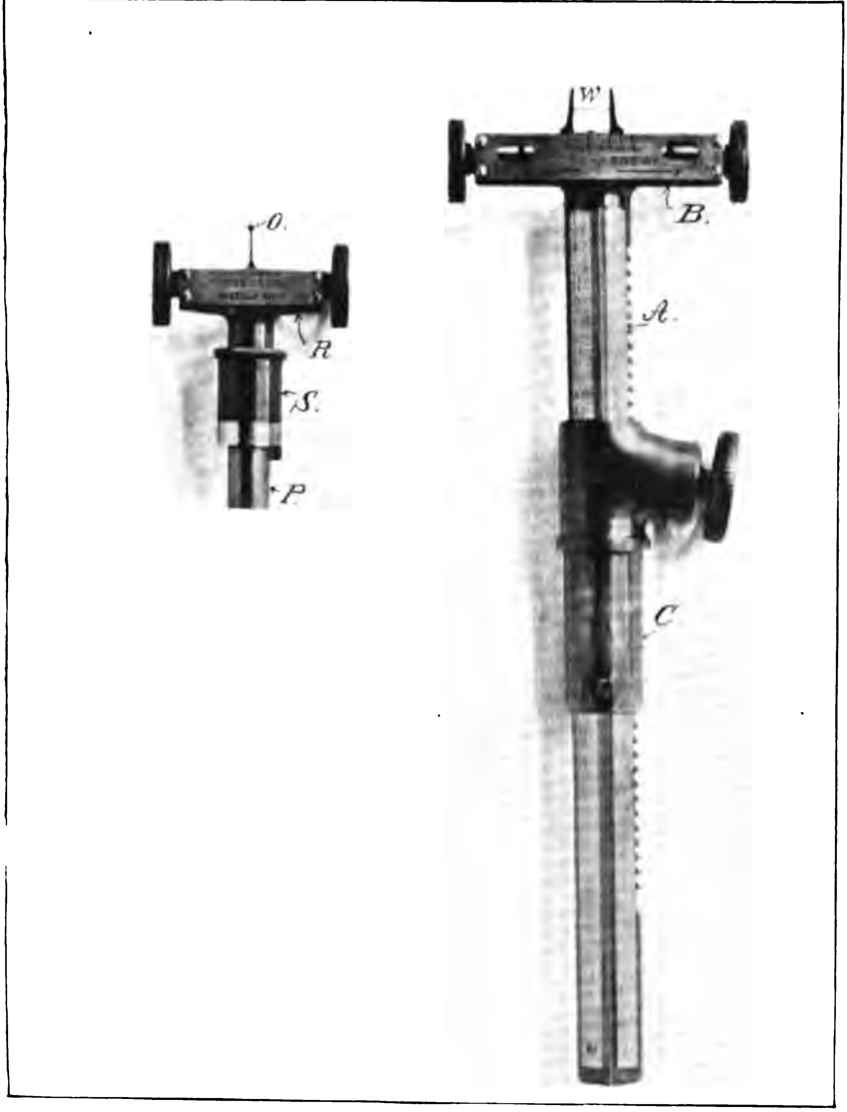
PLATE II.



Appendix 21, 1896.

PARTS OF BREECH MECHANISM. ARMSTRONG 4.7-INCH R. F. GUN.

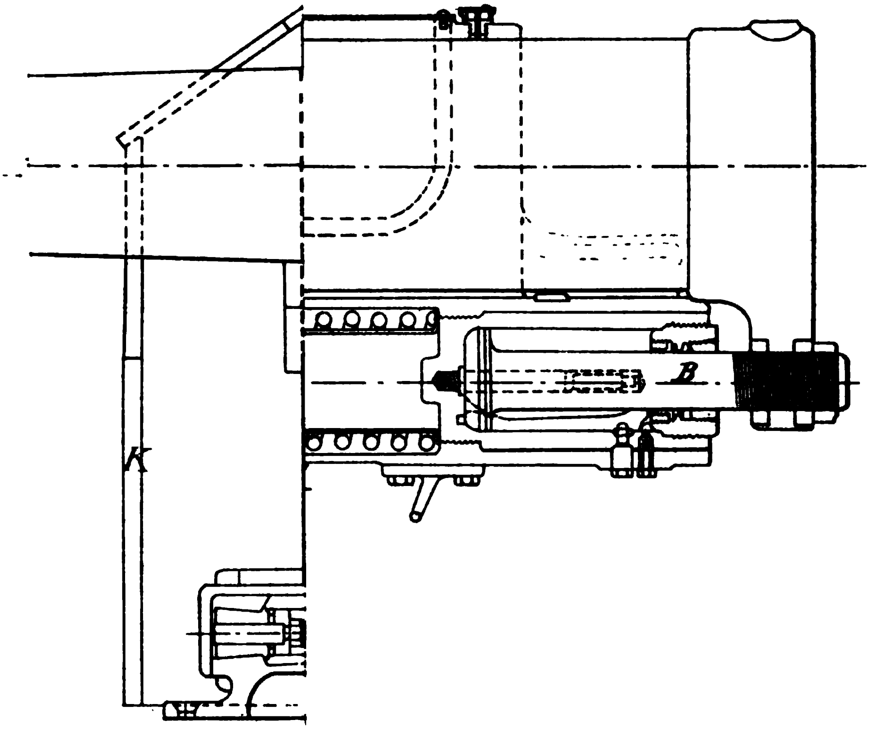
PLATE III.



Appendix 21, 1896.

SIGHTS. ARMSTRONG 4.7-INCH R. F. GUN.

Plate IV.



Appendix 21, 1896

Ord 54 2

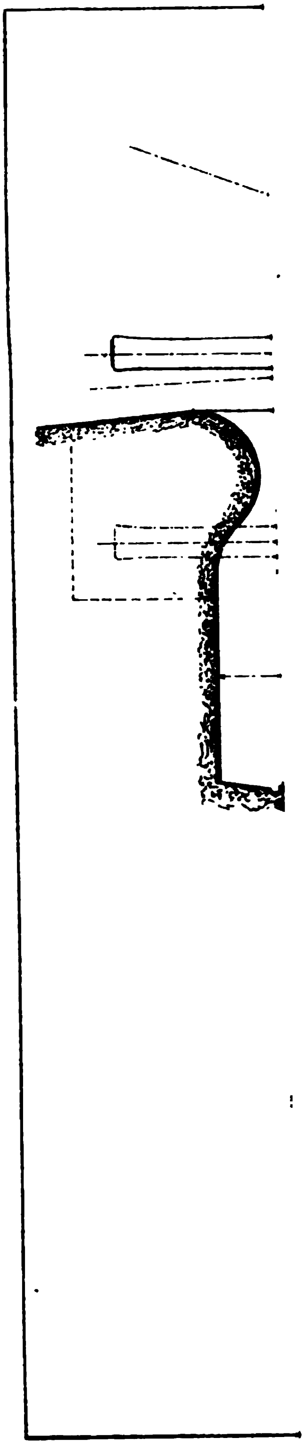
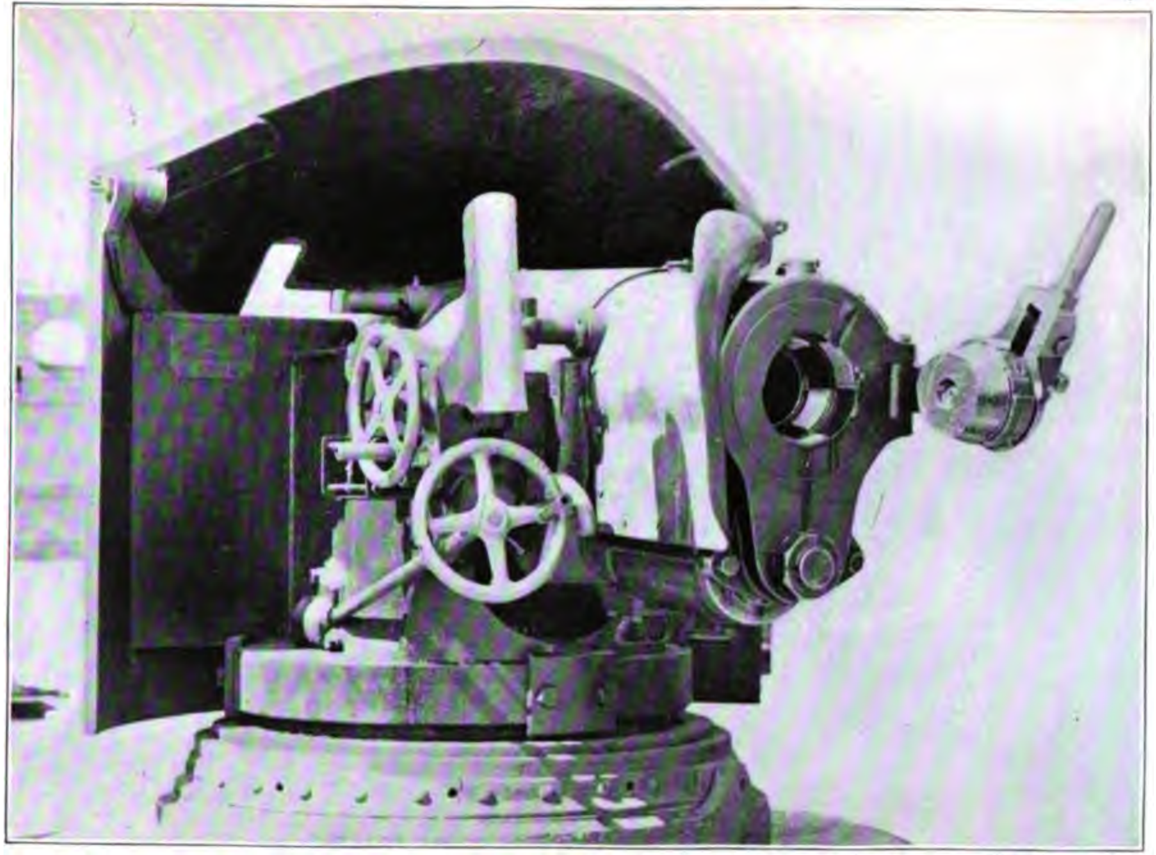
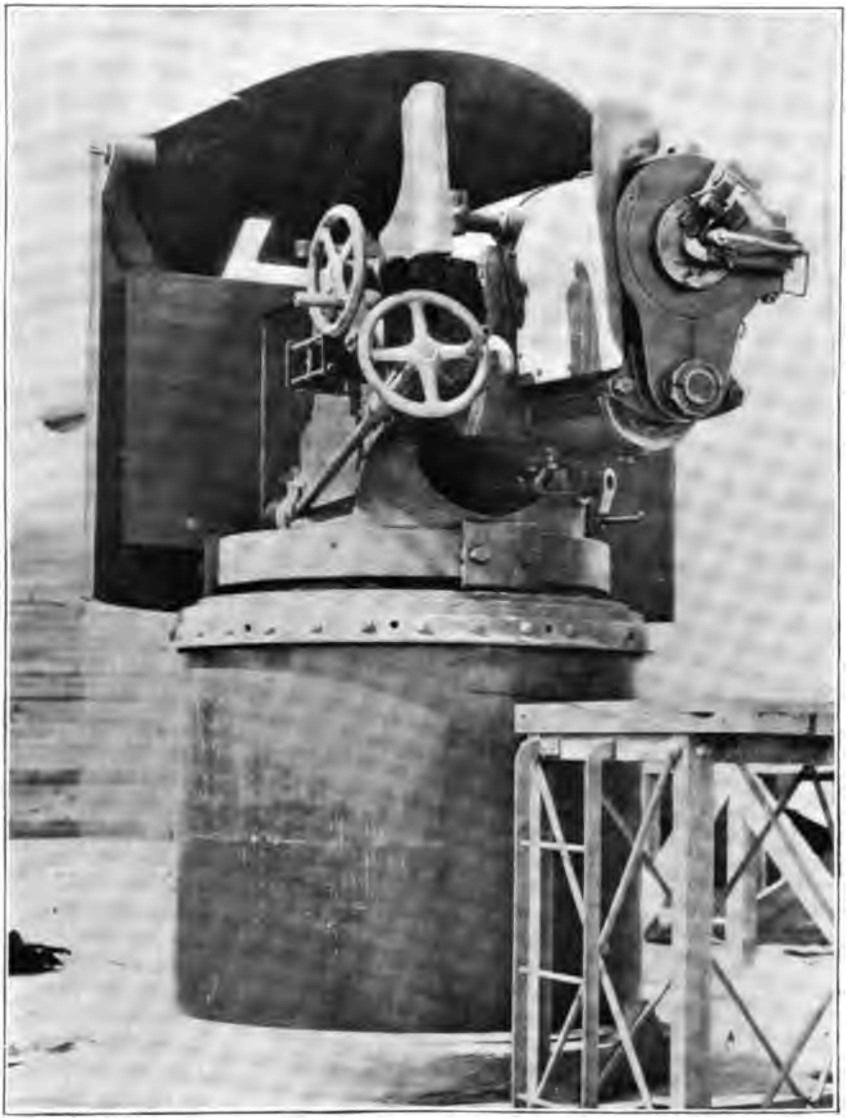


PLATE VI.



Appendix 21, 1896.

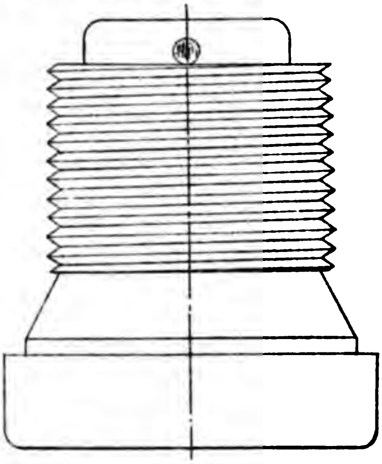
DEPRESSED POSITION. ARMSTRONG 4.7-INCH R. F. GUN.



FIRING POSITION. ARMSTRONG 4.7-INCH R. F. GUN.

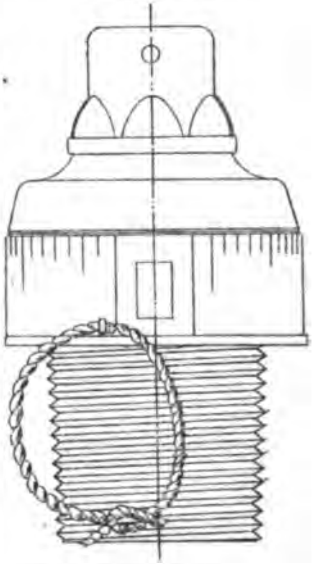
Plate VIII.

BASE CONCUSSION FUZE (BOLT.)



TIME AND CONCUSSION FUZE.

SCALE ½.



Appendix 21. 1896.

Ord 54 2

APPENDIX 22.

TRIAL OF MAXIM-NORDENFELT .303-CALIBER AUTOMATIC MACHINE GUN.

(10 plates.)

THE ORDNANCE BOARD, U. S. A.,
NEW YORK ARSENAL,
GOVERNORS ISLAND, NEW YORK HARBOR,
New York City, November 18, 1895.

SIR: The following report of the test of a Maxim-Nordenfelt automatic machine gun, caliber .303, is respectfully submitted in compliance with your instructions contained in No. 6067, dated March 13, 1895.

DESCRIPTION.

The light or portable Maxim automatic machine gun is a modification of the ordinary well-known type of guns made by the Maxim-Nordenfelt Gun and Ammunition Company, of London, England.

This gun was produced with the object of adapting it for infantry service. For that purpose, the weight of the gun and its mounting have been reduced so that the whole outfit can be conveniently carried in such a manner as to be easily accessible to the soldier. For the purpose of carrying the gun and its folding tripod, a knapsack made of leather has been designed, into which both can be packed and shouldered in less than half a minute.

For cavalry use, cases, or boots, also of leather, are made—one for the gun and one for the tripod. These cases are strapped to the horse's saddle, one on each side. To the knapsack and gun boot is attached a small leather case, containing tools and spare parts for the gun.

The reduction of weight has been effected principally in substituting a light supporting tube for the barrel, in place of the water jacket, common to the other guns, this latter not having been found necessary for the service for which the gun is intended. The barrel of the gun is also somewhat shorter, and several other modifications have been introduced in order to make this gun as light and portable as possible, consistent with strength.

The following is a short description of the gun, reference being made to the accompanying drawings, in which similar numerals indicate corresponding parts in all the figures:

Pl. 1, fig. 1, represents the gun in outside elevation. This constitutes the frame or stationary part of the gun, in which, on suitable guides and bearings, the gun proper or recoiling portion operates.

Fig. 2 shows a vertical longitudinal central section, illustrating all the parts in the position after firing and before the recoil has taken place.

Fig. 3 gives a view of the gun in plan, the cover of the gun being removed.

Pl. 2, fig. 1, represents a vertical longitudinal central section of the breech mechanism and some of the adjacent parts in the position they occupy the instant after the firing, and before the recoil has proceeded far enough to open the breech.

Fig. 2 shows the same parts as fig. 1, but with the breechblock in outside elevation.

Pl. 3, figs. 1 and 2, the same parts as in pl. 2 are represented after the termination of the rearward movement of the mechanism.

Pl. 4 gives a photograph of the breechblock.

Pl. 5 is a photograph of the parts of the breechblock.

Pl. 6 is a photograph of the parts of the gun dismounted.

Pl. 7 is a photograph of the feed box.

Pl. 8 is a photograph of the gun mounted on its tripod ready for action.

Pls. 9 and 10 are photographs of the gun packed in knapsack and carried by a soldier.

All the parts shown in fig. 1, pl. 1, remain stationary when firing, with the exception of the outside crank arm or handle D, fixed to the crank shaft. The crank shaft is supported in bearings which are formed on the inner side or recoil plates R, fig. 2. The right-hand bearing extends through the slot in the outer frame, this slot being sufficient in length to permit the required recoil (of about 1 inch) of the inside frame and its connected mechanism. E is the casing, consisting of the two steel side plates riveted to the bottom plate. The ends are closed in the rear by the gun-metal handle block H, hinged to the side plates at the bottom corner, and in front by the gun-metal trunnion block, cast in one with the supporting tube S and dovetailed onto the side plates. The trunnion block is further secured by a pin J in the upper front corner. This pin also serves as an axis to the hinge of the lid or cover and to the front sight S, which latter can be turned down. The lid or cover is provided at its rear end with a spring latch T, which engages into the handle block, and thus closes the gun. To the handle block is cast the receiver for the rear sight F, and into its pistol grip is placed the trigger with the safety catch U, for locking or freeing the trigger, as indicated.

P is the feed box. This is also shown in plan in fig. 3 of the same plate. L is the resistance piece—a roller, turning loose on the stud, riveted to the side of the side plate. Against this roller bears the cam formed on the under side of the crank handle, and which, during the rearward travel of the recoiling portion of the gun, turns the crank shaft and opens the breech. The cam just referred to has its surface shaped in such a manner that at the beginning of the recoil, and until all the pressure in the gun has subsided, no turning motion takes place, thus keeping the breech perfectly closed.

In order to insure the closing of the breech still better, the forward end of the inside crank C is, when in position, a little above the horizontal bearing of the crank in the recoil plates. The force of the explosion is therefore directed in a line that tends to keep the breechblock closed instead of opening the same.

As the recoil proceeds, the sharp curve on the crank handle comes in contact with the roller, and the leverage begins with a turning movement on the handle, comparatively slow at first, but as the handle is turned the point of contact between its cam and the point of resistance will approach the axis of the crank shaft, and consequently the leverage will diminish as the recoil continues, while the velocity of rotation of the crank will correspondingly increase. This has the effect of opening the breech at first slowly and then more rapidly as the recoil advances. Thus the empty case is started from the barrel of the gun, at first slowly, and in like manner the live cartridge from the belt is inserted in the gun. In addition, the connecting rod U is fastened to the crank C by a toggle joint, the effect of which is to greatly increase the power supplied by the crank handle, particularly during opening and closing the breech.

After the crank has rotated far enough to open the breech, the tail end of the handle comes in contact with the resistance roller on its lower periphery, thereby arresting its movement.

During this period the excess of the momentum of the recoil has been accumulated into the action spring K (figs. 2 and 3, pl. 1, and 1 and 2, pls. 2 and 3, respectively). The reaction of this spring will first return the recoiling portion into firing position and subsequently turn the crank, thereby effecting the closing of the breech, through the following instrumentalities:

The end *k'* of the action spring K is hung to a stud riveted to the left-hand side plate, while its other end *k''* is similarly secured to the rearward-projecting arm of the action lever N. The upper T-shaped end of this lever is pivoted in bearings *e*, one on each side plate and opposite each other, and swings freely thereon, as shown at *n''*. The lower end *n'* of this action lever has pivotally attached thereto one end of the bell-crank lever O. At the bend *o'* and on each side of this bell-crank lever is formed a movable pivot, the end *o''* being provided with a small friction roller. By referring to figs. 1 and 2, pl. 2, it will be seen that the pivot *o* of this lever is engaged and held in the notched bearing projecting from the crank C, and is holding it and the breechblock attached thereto in that position through the constant effort exerted by the action spring.

As the crank rotates either by hand power or under the influence of the recoil, the said notched bearings are brought above the horizontal or dead-center line of the crank C, but before this takes place the free or roller end *o''* of the lever O has already come in contact with the cam surface *t* of the crank and is exerting its leverage against the crank in the same direction as did the now disengaged pivot *o'* in its previous position. (See figs. 1 and 2, pl. 3.) The transmitted effort of the spring against the crank is now in a line very little below the horizontal plane passing through the center of the crank shafts, and consequently involves itself, firstly, in pushing the recoiling portion forward, and secondly, in turning the crank with a gradually increasing velocity and force, thereby closing the breech.

To the wrist pin of the crank is attached the solid end of the connecting rod U, whose other bifurcated ends, with their downward-projecting cams *e*, straddle the breechblock M, and are pivotally attached thereto. The connecting rod U is made in two pieces, joined by means of interrupted fillets, whereby, when the breechblock is lifted out of its guides, it may be given a third of a turn and removed from the gun for inspection and returned, or replaced by a new one, all in a few seconds. As the rear part of the connecting rod is raised to remove the breechblock, it bears against the side of the action spring and is kept in that position for the more convenient reattachment thereto.

The breechblock is guided and supported in its reciprocal movement by its flanges, extending longitudinally on both sides and which slide in grooves near the top edge of the recoil plates R. For the purpose of taking out the breechblock for inspection or for changing the same, the top one of the two ribs forming this groove is cut away at the rear, and in order to prevent the rocking or lifting of the breechblock when at its rear stroke, and before entering the grooves, a guide attached to the under side of the cover comes in contact with the upper surface of it, keeping it down in its place. The top of the breechblock is also made to come in contact with the under side of the cover, so as to give it additional steadiness while in rear position.

The cartridge carrier and extractor *a* slides vertically on guide ribs on the breechblock. This vertical movement is limited by the top stop, forming part of the block, and the bottom stop *b*, secured between the sides of the same by the pin 6, and protruding from its front into the recess of the carrier.

For holding and guiding the cartridges with accuracy, the carrier has on each side of its face a longitudinal flange, into the inner side of which is cut a groove to fit the head of the cartridge. Through the face of the carrier protrude the cartridge stops *c* and *d*. The top stop *c* lies in the upper recess of the carrier, and its two offsets project through the two holes in its face, and is held against and rocks on the bridge formed by them by the pressure of the curved spring 7. The other stop or tail spring *d* is fitted into the lower recess of the carrier, and held there by the pin 8. The upper part of this spring also passes through a hole in the face of the carrier for the purpose of preventing the empty cases from dropping out of its grooves into the bottom of the casing during their transit from the barrel into the ejecting tube X.

The breechblock contains the usual firing mechanism, consisting of the firing pin *h*, which slides between guides, and can strike the cartridge only through the hole in the carrier when the latter is in its upper or firing position. The V-shaped mainspring S, held in place by the pin *l*, has its longer leg engaged into a notch in the firing pin, and its short leg presses against the hand sear *p*, above its axis 2. The tumbler *m* is pivoted to the pin 3 and has its head engaged in another notch in the firing pin *h*, while its lever end or tail is bearing against the lower side of the connecting rod; the safety sear *r* is placed immediately above the firing pin; the head of this sear is pivoted to the pin 4, and its tail end lies over the upper side of the connecting rod and directly opposite the tail end of the tumbler *m*.

In order to give a clear description of the operation of the breech mechanism, reference has to be made to fig. 2, pl. 1, and figs. 1 and 2, pls. 2 and 3, respectively.

In fig. 2, pl. 1, and figs. 1 and 2, pl. 2, the breechblock is shown in firing position, the carrier holding between its flanges and the gib *c* a live cartridge, located in the feed box P, and another live cartridge is held between the same flanges in the chamber of the barrel immediately below, and an empty case, freed from the carrier, lies in the ejecting tube X, and is held there from falling back into the gun casing by the ejecting-tube spring.

If the explosion takes place, the whole inside portion travels backward with the breechblock still firmly locked to the barrel until the outside crank comes in close contact with the resistance roller L, and the crank begins to turn downward, carrying with it the connecting rod, whose other end draws away the breechblock from the barrel.

The carrier also recedes, with the live cartridge drawn from the belt and the empty case from the barrel, guided and supported by the horns projecting sidewise from its upper end, and which ride over the straight part of the side cam I, riveted to the side plates (fig. 2), until the live cartridge just drawn out of the belt is clear of the feed box. Then the horns follow the downward-curved edge of these cams, guided from the top by an inversely curved cam, formed on the guide piece for the breechblock, and which is riveted to the under side of the cover. During this period the connecting rod in its downward movement presses against the tail of the tumbler, which, in its turn, draws back the firing pin and compresses the mainspring until the sear *p* engages into a notch in the tumbler and the safety sear reengages with a shoulder on the firing pin. When nearly at the end stroke of the breechblock the carrier horns leave the points of the side cams I and the carrier drops into its bottom stop by its own gravity and assisted by the guide directly above it. This brings the cartridge, drawn from the belt, to incline with the chamber of the barrel, and the empty case in line with the ejecting tube. The crank, having now completed its rearward turn, begins its return stroke; the advancing breechblock now forces the live cartridge on the carrier into the chamber, and the empty case on the carrier is thrust against the empty case in the ejecting tube, throwing the latter out in front of the gun. In this operation the carrier is steadied by its horns being kept in contact with the lower surface of the side cams. As the crank returns toward its horizontal position, projecting cams *e*, or side levers of the connecting rod, come in contact with the ends of the lifting levers *g*, pivoted to the breechblock and held thereto by the lifting-lever clip *f* straddling the same and secured thereto by the pin *l*. The other ends of these lifting levers *g* are engaged between two lugs, formed on the carrier, so that when they are turned on their pivots by leverage of the cams *e* on the connecting rod, the carrier rises with a steadily increasing velocity, the lower part of the upper stop *c* slides over the head of the live cartridge in the chamber, and its tail spring over the head of the empty case left in the ejecting tube and held there by the ejecting-tube spring, to prevent it from falling back into the gun; while at the same time the upper part of the upper stop *c* slides over a fresh cartridge in the feed box and retains it in position between the grooves of the carrier and the upper and lower parts of the stop *c*.

When the carrier has arrived at the top, the end of a leaf spring, riveted to the right-hand recoil plate, drops into a notch cut on its side and keeps it in that position until, in its rearward travel, the horns slide onto the side cams and support it.

The crank and connecting rod, having resumed their firing position, are bracing the breechblock hard against the breech. At the last moment the connecting rod has lifted the safety sear and freed the firing pin. The effort of the mainspring is thrown upon the hand sear. If now the trigger bar at the bottom of the gun casing is moved to the rear by pulling the trigger T, connected thereto, the tail of the hand sear will strike against the lug at the free end of this bar and set free the firing pin, the point of which will pass through the hole in the carrier and explode the cartridge, and the whole cycle of operations will be repeated at the rate of $\frac{1}{10}$ second or 600 per minute as long as the trigger is kept pulled or there are cartridges in the belt.

The feeding of the cartridges into the gun is accomplished in the following manner: The cartridges are placed in the belt, formed of two pieces of tape fastened together by eyelets and brass strips. The belt is made thick at the edge next the bullets by being folded over a cord, so that the cartridges may lie even in their boxes, while every fourth brass strip is made to project beyond the bullet edge of the belt a distance equal to that of the bullets, thus rigidly maintaining in the boxes the exact position of the cartridges in the belt.

The box or magazine which contains the belt filled with cartridges is made of leather to insure lightness, and in order to keep its shape it is strengthened with steel ribs. This box is either hooked to the studs riveted to the gun below the feed box P or simply placed on the ground when the gun is in action, and one end of the belt is passed through the feed box.

The lever Z (fig. 1, pl. 3) is operated in such a manner by the reciprocating action of the barrel that the cartridges are drawn into position one by one. The curved guide pieces or ears *q* keep the belt of cartridges in the proper position as it enters the feed box. In the passage through the feed box there is a slide V, with a spring pawl operated by means of a two-armed lever Z, pivoted at the side of the feed box. One arm of this lever is slotted, and engages with a stud on the slide V. The other arm of the said lever is arranged to be acted upon by a notch in the arm of the left-hand recoil plate.

During the recoil this lower lever will be rocked upon its pivot, and, by means of the spring pawl acting on the cartridges, feed the belt intermittently through the feed box. A spring retaining pawl is fitted to the under side of the feed box to prevent any backward movement of the belt. A wooden roller between the two ears of the feed box secures the easy passage of the belt through the latter.

MOUNTING.

The mounting consists of a light tripod, the legs of which are made of steel tubing. The two short front legs, which are locked to the rear leg when mounted, can be folded against it when dismounted. The rear leg is made in two pieces, joined by a hinge, which allows the two parts to be folded up. The lower end of this leg carries a seat for the gunner, and on its other end is formed a pivot which stands vertical when the tripod is mounted. Onto this pivot can be shipped a Y-shaped socket, between the arms of which the gun is mounted on the axis pin *h*. The rear end of the gun is supported by the elevating gear, which is joined to the end of a radial arm from the Y socket. The upper part of the elevating gear is ⍦-shaped, and the rear part of the casing is held between the arms of the ⍦ by an axis pin. The stem of the ⍦ is a long nut which engages with a screw on the arm. Turning of the long nut gives the elevation. The end of this arm can be clamped to an arc fixed to the long tripod leg, or may be swung thereon freely in direction between the spring stops provided at each end of the arc. On depressing either one of these stops, the gun, with its connected socket and elevating gear, may be swung, and when at a right angle with the long leg can be lifted off the pivot; then by removing the pin holding the elevating gear to it, the gun, elevating gear, and socket may be together placed in the knapsack; the tripod is then folded up and placed beside the gun and strapped thereto.

LOADING AND FIRING.

To load the gun, pass the end of the belt through the feed box, and as it comes through seize it with the left hand, and with the right hand turn the crank handle forward until it stops and hold it in that position, then with the left hand pull the belt through the gun as far as it will go; remove the right hand and let the crank handle return to the firing position of its own accord. By this operation, one loaded cartridge in the belt has been brought into position and seized by the carrier.

Now turn the crank handle forward again and draw on the belt as before, and again, of its own force, let the handle return to firing position; this thrusts the first loaded cartridge into the chamber of the gun and at the same time engages a fresh cartridge in the belt.

The gun is now properly loaded and ready to perform all these operations automatically. Neither the crank handle nor the belt require any further assistance. It is necessary now only to hold the trigger back, as the force of the first shot fires the second, and the second the third, and so on, as long as the trigger is pulled, or until all the cartridges in the belt are exhausted; when it is necessary, of course, to proceed as before to again load the gun.

The gun may be discharged by single shots, or in volleys of any number of rounds, by pressing the trigger for the number of shots desired.

When it is desired to make a very close target, the gun may be adjusted with great nicety by the training gear and discharged on a given point; or it may be secured against any lateral movement and discharged on a vertical line, and elevated and depressed with perfect freedom to cover any point of that line; or the gun may be secured against any vertical movement and adjusted to be traversed laterally, and limited to exactly cover any desired portion of a line of advance.

Particulars.

Caliber	inch..	.303
Weight of gun	pounds..	25
Weight of tripod	do....	13
Weight of ammunition box containing 100 rounds	do....	8
Weight of knapsack	do....	12
Length of gun over all	inches..	39
Length of barrel	do....	22
Axis of gun from ground	do....	36
Rate of fire per minute		600

Throughout the test the gun was operated under the immediate supervision of an assistant proof officer by a representative of the Maxim-Nordenfelt Company.

PRELIMINARY FIRINGS.

The gun was first fired 100 rounds for the purpose of testing the general working of the mechanism. All of the parts worked smoothly and satisfactorily. Fifty rounds were then fired as rapidly as possible in 5⅘ seconds.

The gun was then placed in its knapsack and the latter strapped on the back of the operator as on the march. From this position the knapsack was removed, the gun placed in firing position, and 50 rounds fired. Time required for the operation, 58 seconds.

The spare mechanism was strapped in the knapsack and placed alongside the gun. The gun was loaded and one round fired. The carrier was then interchanged for the spare one and another round fired. Time required from firing of the first round to completion of the second, 26⅖ seconds.

The extra barrel being placed in the knapsack alongside of the gun—knapsack open—one round was fired, the barrels were then interchanged, and another round fired. Time required from firing of first round to completion of second, 1 minute 12⅖ seconds.

To show the action of the mechanism in case of missfire a cartridge was rendered defective so as to insure a missfire and placed in one of the loops of the cartridge belt. When this cartridge was pushed into the chamber and its primer hit by the firing pin, there was of course no recoil. The crank handle was then turned forward by hand and the defective cartridge ejected. A second turning of the crank handle pushed a live cartridge into the chamber and the firing proceeded as before. Two attempts were necessary to perform this operation satisfactorily.

To fire blank cartridges, a casing was placed over the muzzle having a small orifice for the escape of the gas. This arrangement is necessary in order to secure sufficient energy of recoil to work the parts of the mechanism in the same manner as when bullet cartridges are used. The gun was then tested satisfactorily with blank cartridges.

ACCURACY AT 500 YARDS.

The target was 7½ by 9 feet in dimensions, and placed with the longer side horizontal. The tripod and gun were placed on a platform of wood laid on concrete. Thirty sighting shots were fired.

First five went high and missed.
Second five went left and one hit.
Third five went left and one hit.
Fourth five went left and three hit.
Fifth five went left and last four hit.
Sixth five went more to the right and four hit.

One hundred rounds were then fired in 11 seconds, with 18 hits well up in the left-hand angle of the target. The tripod moved during the firing of these rounds, and a second attempt was made. Before firing the second 100 shots, the gun was placed on a clay platform, and 10 sighting shots were fired. Of the first five, one hit to left; second five, three hit to left. The 100 shots were then fired, with 69 hits, 50 in the upper right-hand corner and 19 in upper left-hand corner.

ACCURACY AT 1,000 YARDS.

The target was 12 feet by 15 feet in dimensions and placed with the longer side horizontal. The gun was mounted on a wooden platform. Six series of five shots each were fired for sighting shots. The first three series were fired using the elevation for 1,000 yards, the gun being sighted about 3 feet below the bull's-eye, 2 feet to the left of the bull's-eye, and at the lower left-hand corner respectively. No hits. The fourth series was fired with the elevation for 900 yards, using a coarse sight and aiming to the left of the center. One hit about 6 inches from top and 18 inches to the left of center. In the fifth series the same elevation was used, sight fine, and aim a trifle to the left of center. Four hits in upper right-hand corner. In the sixth series the elevation was 850 yards, sight coarse, and aim as before. Three hits in same place as in fifth series.

The 100 shots were then fired as rapidly as possible, elevation 800 yards, sight coarse, aim as before. Number of hits 99. A photograph of this target accompanies this report.

DUST TEST.

In all the firings above described a perfectly new gun was used, conforming in all respects to the latest model. As the company did not desire this gun to be subjected to the wear and tear resulting from the test for dust, rust, defective cartridges, etc., a gun was substituted for the latest model which differed from the latter in that the casing was provided with a slot on its left side in which the interior casing slides during recoil, and with a spring on the cover which acts as a guide to the carrier. The gun was much lighter than the latest model, many of the parts being made of aluminum, and the breech casing being much thinner and weaker.

For the dust test the breech mechanism was thoroughly washed in hot water and soap, well dried, and slightly oiled. It was then subjected to a blast of fine dust for 8 minutes. The operator made no attempt to remove the dust other than by jarring the piece and working the mechanism. The first round was fired in 52 seconds. On account of the dust which remained in the chamber, the empty cartridge case stuck, the extractor removing the head and leaving the remainder of the case in the chamber. It required 2 minutes and 45 seconds to remove the broken shell and prepare the gun for firing. Ninety-eight rounds were then fired in 44 seconds. During the first part of this firing the recoil failed twice to work the piece, the energy of recoil being insufficient to overcome the increased friction of the moving parts caused by the accumulation of dust.

DEFECTIVE CARTRIDGES AND BLOW BACKS.

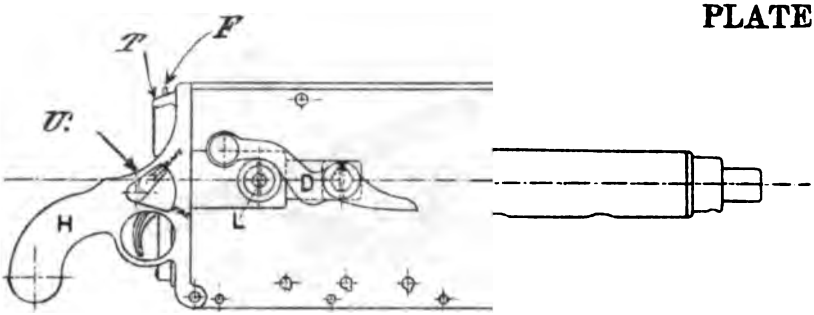
The cartridges were rendered defective, first, by sawing two slots through the head of the cartridge at right angles with each other and reaching the interior of the shell; and second, by sawing four slots through the rim of the cartridge in a radial direction at equal distances apart and reaching the interior of the shell by boring holes through the slots.

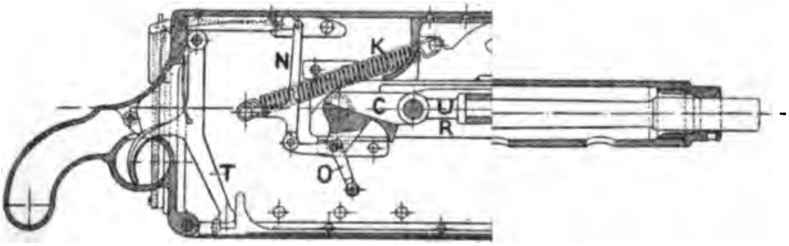
Two shots were fired with No. 1 defective cartridges. In both cases the breech casing was filled with dense smoke and the action spring was thrown out of bearing. The shell was removed by hand, no attempt being made to use the ejector. It required about 45 seconds to replace the spring and prepare the gun for firing. Two defective cartridges of No. 2 style were then tried; the action and results were the same as in previous rounds. A defective cartridge of the No. 2 kind was tried to see if the ejector would work. The action of the mechanism was the same as in previous rounds. The ejector failed to remove the shell. The defective head expanded in the extractor and the power was insufficient to move it. It was therefore removed by hand. A No. 1 defective cartridge was then tried. The action of the mechanism was the same as before; the ejector removed the shell, and the trial was then made of a No. 2 shell. The ejector could not remove the shell. After firing a defective cartridge the time required to remove the shell and put the gun in condition for further firing was 45 seconds.

For the blow-back test, the primers had the larger portion of their rear end removed, thus permitting the ready escape of gas to the rear. First round: Slight escape of gas through mechanism; the mechanism was not disturbed and its action was the same as with a perfect cartridge. Second round: Escape of gas about the same as before; one bearing of the action spring was thrown out; the ejector worked perfectly.

At the completion of these tests the gun was fired 20 rounds of service cartridges. At the tenth round the action spring was thrown out of its bearing. The time required to fire the 20 rounds, including the replacing of the spring, was 27 seconds. An examination showed that the side casing had bulged slightly, causing an insufficient support of the action spring in its bearing; in other respects the parts were in good condition. The gun was again fired 20 rounds. At the third round the

PLATE I.





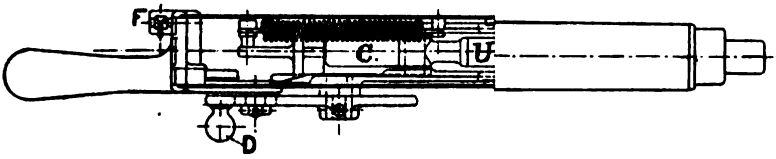


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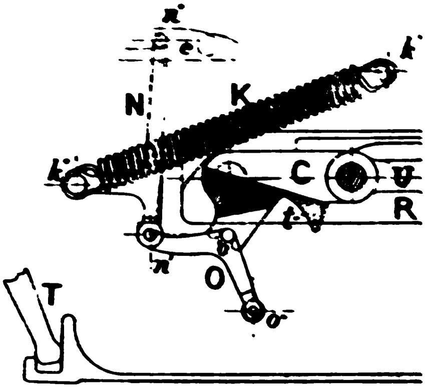
PLATE II.



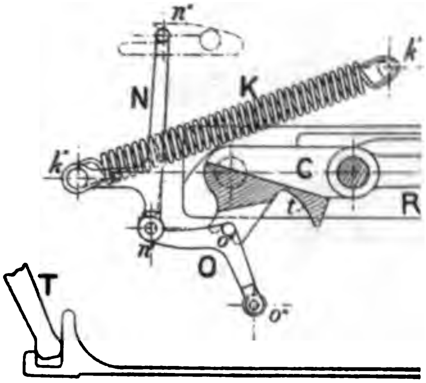


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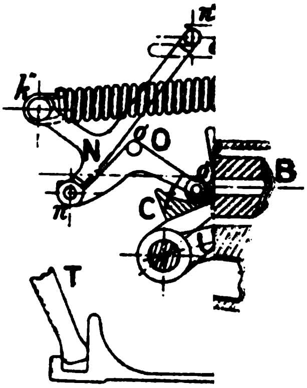
PLATE III.



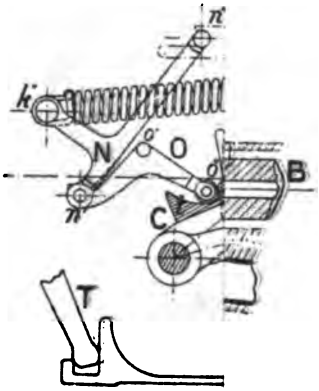


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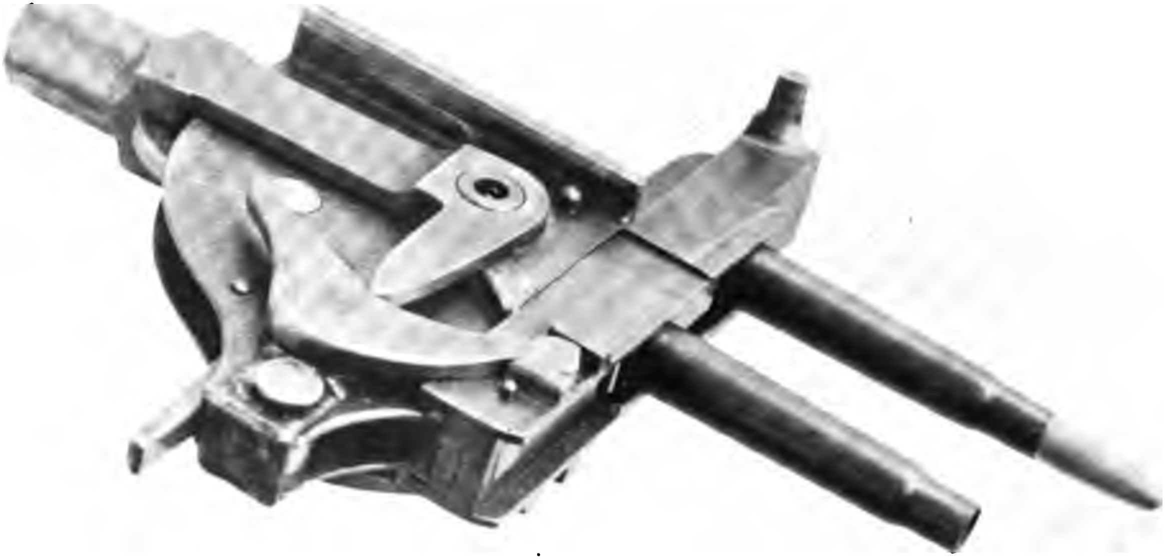
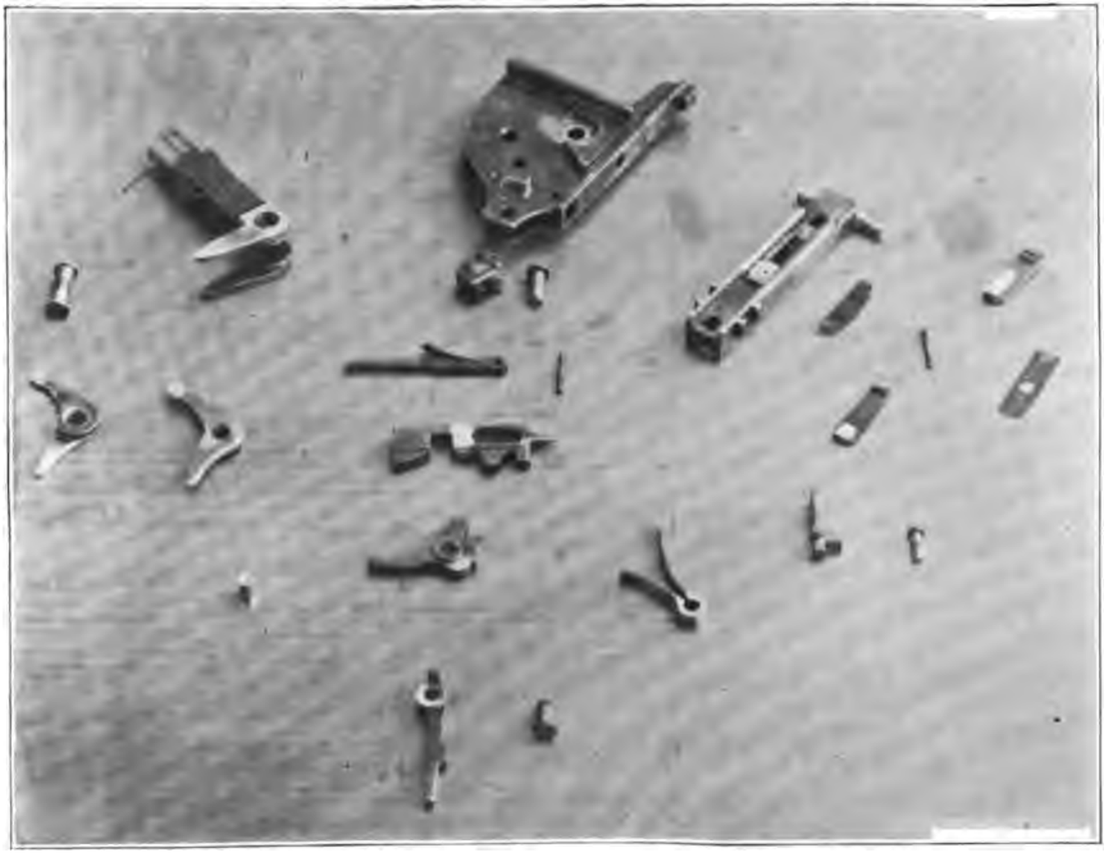
PLATE IV.



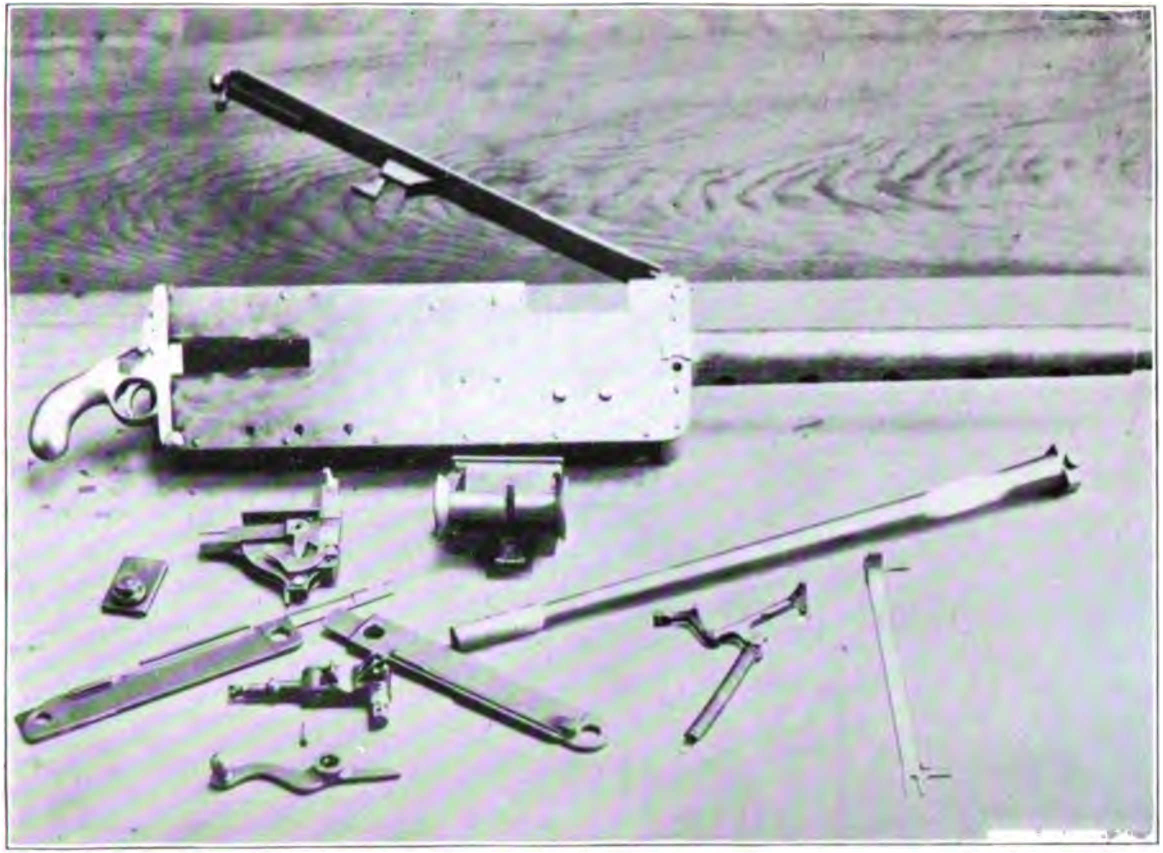
Appendix 22, 1896.

PLATE V.



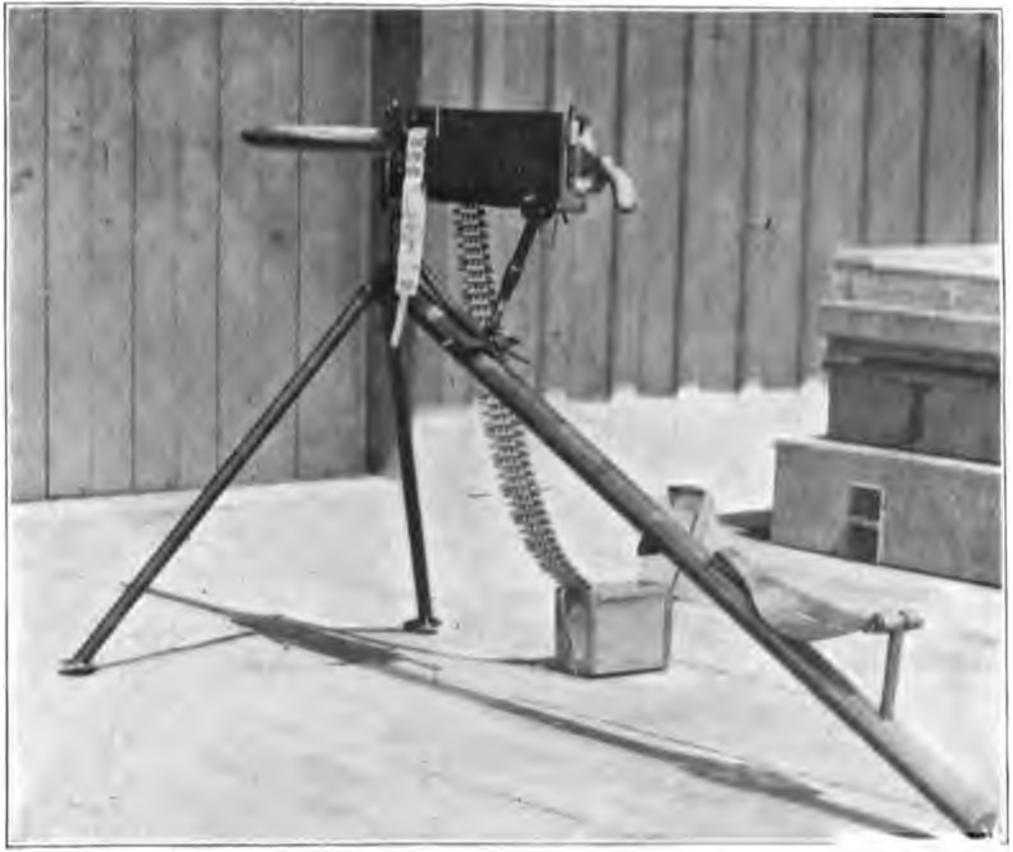
Appendix 22, 1896.

PLATE VI.



Appendix 22, 1896.

PLATE VIII.



Appendix 30, 1900.

PLATE IX.

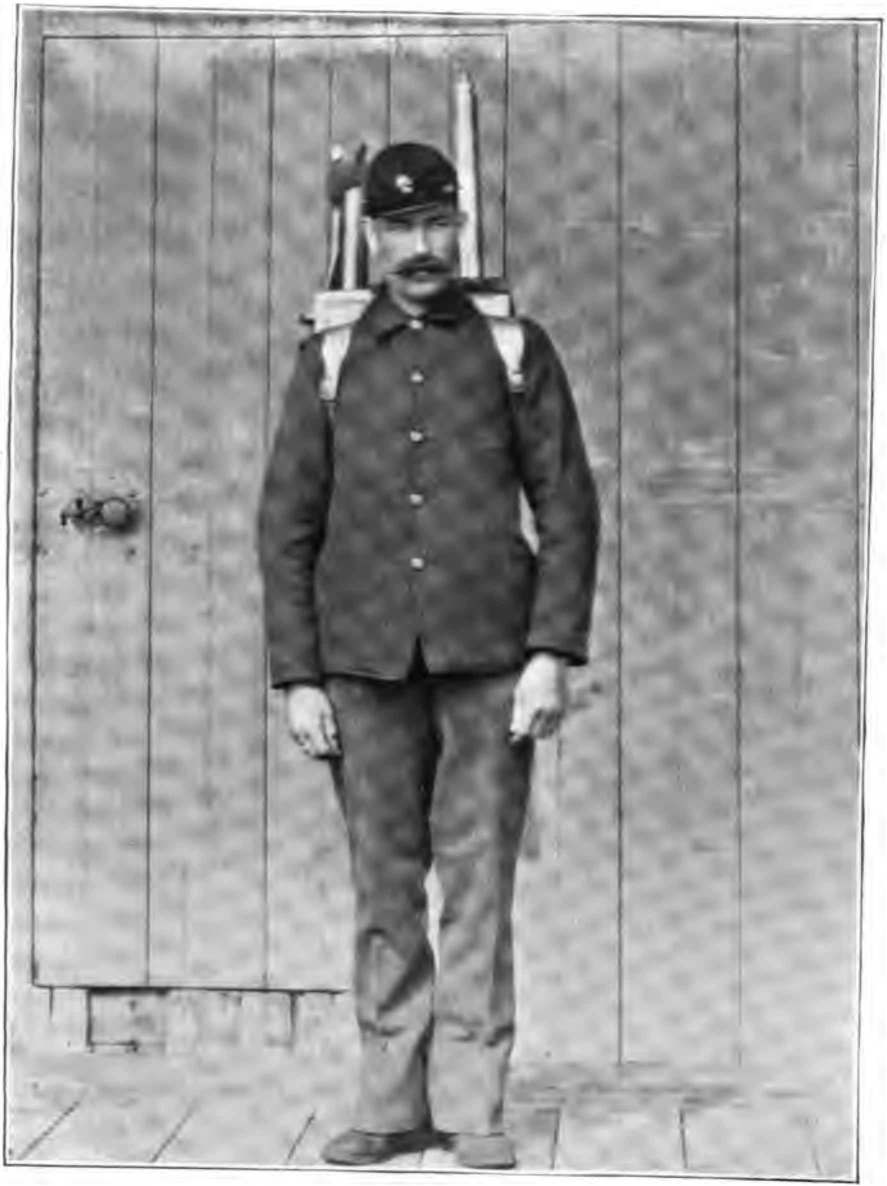
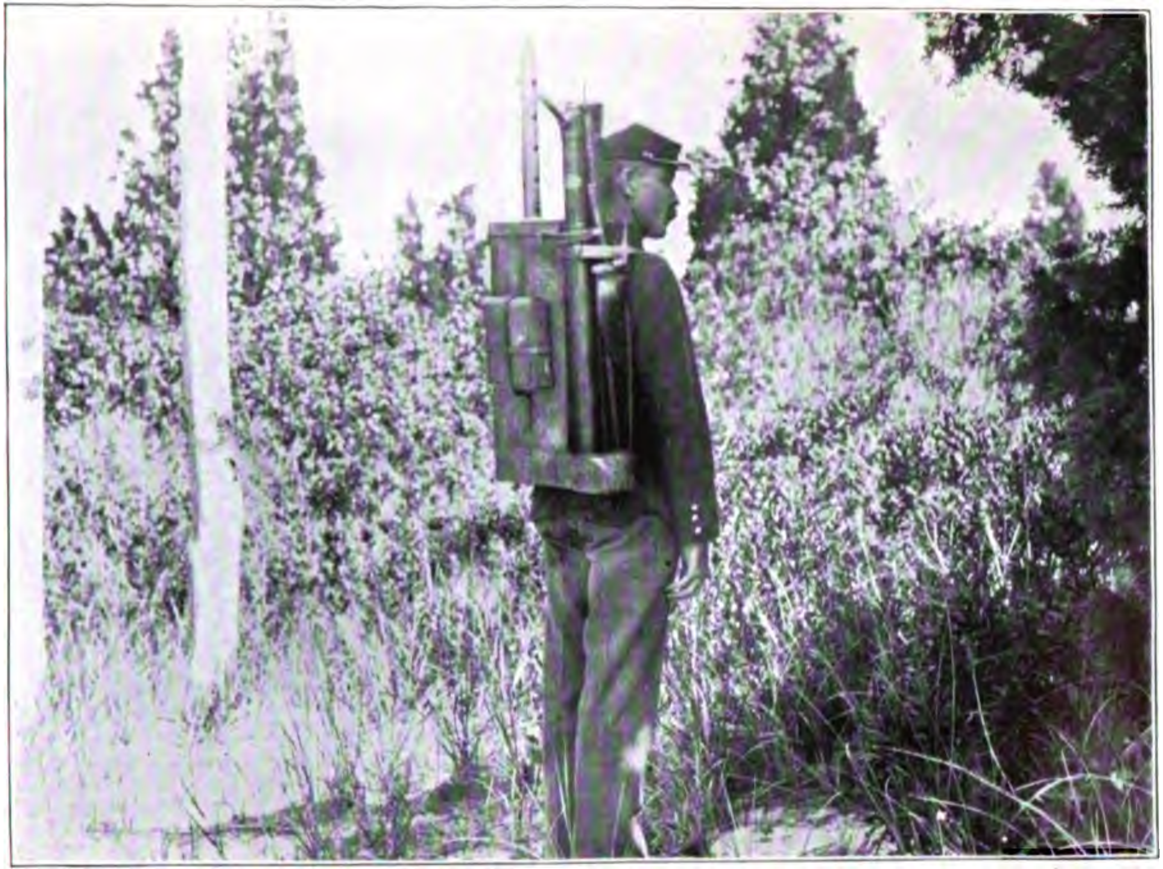


PLATE X.



Appendix 22, 1896.

APPENDIX 23.

TRIAL OF CANÉT 12-CM. (4.72-INCH) RAPID-FIRE GUN AND MOUNT.

(17 plates.)

THE ORDNANCE BOARD, U. S. A.,
NEW YORK ARSENAL,
GOVERNORS ISLAND, NEW YORK HARBOR,
New York City, March 23, 1896.

SIR: The following report of the test of a Canét 4.72-inch rapid-fire gun and mount is respectfully submitted:

DESCRIPTION.

THE GUN.

The gun consists of a tube, jacket, and a hoop in prolongation of the jacket.

The tube extends the entire length of the gun, inclosing the breech mechanism. For the latter it has four threaded and four plain sectors, with a groove and seat for the extractor, and a corresponding seat diametrically opposite for one of the claws of the screw extractor.

The chamber has a shoulder against which bears the rim of the cartridge case, and a conical part for the body of the case, and a cylindrical part for the neck. A conical portion, connecting the cylindrical part with the rifling, forms the forcing cone.

The rifling, right-handed, commences in the forcing cone and, at first increasing, becomes subsequently constant. A locking shoulder on the exterior of the tube transmits the strain from the tube to the jacket.

The rear portion of the jacket constitutes a circular slide, which moves through the rear sleeve of the cradle. Forward of this slide are two recesses for the rear and front segmental collars, which hold the cylinder connected with the hydraulic brake to the jacket.

The hoop is shrunk over the tube and over a shoulder on the jacket.

The following are the principal characteristics of the gun:

Weight	pounds..	5,830
Total length (4.8 meters)	inches..	188.976
Diameter of bore (12 centimeters)	do....	4.724
Number of lands		30
Initial inclination	degrees..	3
Final inclination	do....	6
Length of rifling (3.83 meters)	inches..	150.79

BREECH MECHANISM.

The breech mechanism is composed of four principal parts:

1. The breech screw with the extractor.
2. The combined carrier and console.
3. The operating mechanism.
4. The firing mechanism.

(1) The breech screw A is of steel, and has upon its cylindrical surface four threaded and four plain sectors, recesses for the extractors, latch pin, and the screw bolt which binds together the axis of movement, the toothed ring and the breech screw. Recessed in its front face is a screw hole for the firing-pin bushing, and in its rear face are recesses for the safety pin and toothed ring, and, in addition, a small cylindrical opening for the working of the extractor-relieving pin.

The extractor G is a lever having at its front end a claw, at its middle an axis about which it rotates, and at its rear end a tail with a face sloping to the rear, and a back bearing against a spring, which causes the claw to bear against the cartridge rim.

The toothed rim C is a frustum of a cone and fits in the recess *e* in the breech screw. Upon its rear surface is a bevel gear of one cog and two half cogs, in which the vertical axis engages and rotates the block. The toothed ring is tapped centrally for the axis of movement D, and has upon its rear surface two openings; one, the larger, a recess for the safety pin, and the other a through hole for the passage of the extractor-relieving pin.

(2) The combined carrier and console B is a steel forging, and consists of the carrier ring and the console proper.

The carrier ring has a radial recess for the latch pin, which locks it to the breech screw during the swinging of the block. Upon closing the block a conical dowel in the face of the breech releases this pin. On the carrier are two guides which work in grooves on the breech screw during its withdrawal, and the hinge piece, through which and the breech of the gun, passes the hinge pin H, upon which the block swings.

The console is composed of two slides and a transverse piece T in rear connecting them. Upon these slides moves the bronze support J, which forms the rear bearing for the block, the front one being the carrier ring. The left slide has a projection on its left, and underneath both is a grooved cam, in which works a roller stud on the smaller arm of the operating lever during the withdrawal of the block. A recess on right side forms a rest for the smaller end of the operating lever when the block is locked. A stop bolt on the interior of the left slide limits the rotation of the block prior to withdrawal.

(3) The operating mechanism has as its principal parts the operating lever L, the vertical axis F, the axis of movement D, and the bronze support J.

The operating lever has two arms. The larger is terminated by an upright sliding handle N; the other by a roller stud which works in a grooved cam underneath the left slide and withdraws the block. The sliding handle on the larger arm actuates a locking lever Y, which is recessed underneath the larger arm and pivoted about a horizontal axis. One end of the locking lever is bolted to the sliding handle and held in its locked position by a spring within the latter; the other end engages in a bracket on the face of the breech. Pressure on the sliding handle unlocks this lever by disengaging it from the bracket and permits of rotation of the block. The junction of the two arms forms a bearing for the vertical axis.

The vertical axis F is a single piece, the head of which is enlarged to form a bevel sector of two teeth, which engages with the gearing on the toothed ring and rotates the block. The vertical axis constitutes the axis of the operating lever, during rotation of the block, and is keyed to the latter by the pin M, which is clamped by a milled head. The vertical axis has a cam which bears against a stop bolt on the interior of the left slide and limits rotation of the block prior to withdrawal.

The axis of movement D is a hollow tube screwed into the breech screw and connecting longitudinally the breech screw, the toothed ring, and the bronze support. When in position it constitutes a part of the first two and is free to rotate in the latter. It is held in rear by the interrupted screw nut O. This axis withdraws the block by transferring the motion from the bronze support to the toothed ring and breech screw, and, in addition, it forms a receptacle for the hammer, with its parts.

The bronze support is in two parts dovetailed into each other. The smaller and front part K furnishes the front half, and the larger and rear part J the rear half of the bearing for the vertical axis. The larger part contains the bearing *j* for the axis of movement, and, in addition, recesses *a* and *b*, for the safety and extractor-relieving pins, and bearings *c* and *d* for the axes of the trigger and sear. This support slides on the console, drawing back the block.

The process of opening the block is as follows (Pls. II, III, IV, and V): To unlock the breechblock, press on the sliding handle of the operating lever, releasing the locking lever. To rotate the block, draw the handle to the rear, which rotates the verticle axis and, through the bevel gearing, the block, until the cam on the vertical axis bears against the stop bolt. Further motion of the handle transfers the motion to the roller stud and withdraws the block. When the block is in this position (Pl. IV), the handle is directly to the rear, and further withdrawal is stopped by the transverse piece on the console. The operating lever now moves forward and to the left, swinging the block aside for loading and describing throughout the entire operation approximately an angle of 180 degrees.

(4) The firing mechanism consists essentially of a firing pin, hammer, safety pin, sear, and trigger.

The firing pin R is a short conical pin, seated in a bushing screwed in the front face of the breech screw.

The hammer S, which strikes the latter, has upon its rear surface a shoulder which is engaged by the sear. Surrounding the hammer is a spiral spring held in place by two locking rings.

The sear *u* has a lug end which engages under the shoulder on the hammer, drawing it out and releasing it, and a tailed end which engages in a mortise in the safety pin. It has a vertical axis fixed in the rear surface of the bronze support at *d*, and is actuated by the safety pin, which in turn is worked by the trigger.

The safety pin V works in a cylindrical opening through the bronze support and into the breech screw. Only when the recess in the screw is exactly opposite the opening in the bronze support (i. e., when the block is locked) can the safety pin actuate and fire the gun. The safety pin has surrounding it a spiral spring which supports it and keeps it withdrawn from the recess in the breech screw.

The trigger X is a lever pivoted about a vertical axis at *c*, and having its outer end perforated for a lanyard and its inner shaped so that it will engage in a mortise in the safety pin.

The process of firing includes also that of cocking. The outward pull on the trigger forces inward the safety pin. This last motion draws in the end of the sear engaged in the safety pin and forces out the lug end, cocking the hammer. At a certain point the lug end releases the hammer, firing the gun.

The important accessories to the breech mechanism (Pl. XIII) are the extractor relieving pin A and the screw extractor B. These are used in case of jamming of the cartridge case. The relieving pin A is a spindle which, bearing against the sloping face of the extractor, relieves the claw from the rim of the cartridge case and permits the withdrawal of the breechblock. The screw extractor has two claws, a screw piece, a pair of shoulders which fit loosely about this piece, and a nut. The claws embrace the rim of the cartridge case, the shoulders bear against the face of the breech, and power is applied through turning the nut.

Nomenclature, Plate I.

Name.	Parts.	Name.	Parts.
A—Breechblock	4	J—Bronze support	2
G—Extractor	4	R—Firing pin	1
B—Combined carrier and console	4	S—Hammer	6
L—Operating lever	7	U—Sear	2
F—Vertical axis	3	V—Safety pin	2
D—Axis of movement	2	X—Trigger	2

THE MOUNTING.

(Plates VI and XI.)

The mounting is composed of—

1. A plate-iron conical pillar bolted to the concrete platform.
2. A base ring bolted to the conical pillar.
3. A chassis resting upon the base ring.
4. A loading platform.
5. A cradle which carries the gun.
6. A shield.

The system formed by the chassis, the loading platform, and the cradle revolves about a central pivot for traversing, and the system formed by the cradle and the gun revolves about the trunnions for elevation.

THE CONICAL PILLAR.

The pillar A is a frustum of a cone. It is made of plate iron, braced on the interior with two diameter plates connected with each other, the exterior conical plate, and the upper base plate by angle irons. The upper base plate of the pillar, to which the base ring is bolted, is fastened to the conical part by a circular angle iron. The pillar carries midway a circular roller path for the rollers which support the loading platform. In the lower part are placed radial troughs for 8 rounds of fixed ammunition. The pillar is secured to a concrete foundation by a circular flange on its exterior, which is riveted to the pillar and bolted to the concrete.

THE BASE RING.

The base ring B is of cast steel, and includes the lower roller path, the circular rack for traversing, and the pivot. On its exterior surface are two flanges, the lower, through which it is bolted to the roller, and the upper, underneath which bear the clips attached to the chassis.

THE CHASSIS.

The chassis C is a single piece of cast steel, and consists of two cheeks, a bottom plate and a front transom. The cheeks carry the bed plates for the trunnions of the cradle, and have each a vertical rib, to which is bolted a lateral support for the shield. To the rear end of each cheek is bolted a support for the loading platform. On the right cheek are the bearings for the pump and its parts, and on the left cheek are brackets for the elevating, and parts of the traversing mechanism. The front transom has a rib to which is bolted the front support of the shield. The bottom plate or racer is fashioned to embrace the pivot of the base ring, and on its exterior it is grooved for the vertical arbor of the traversing mechanism. It is provided with two clamps, D, for holding it down during recoil, and two steel plates, E, which serve as a dust guard.

THE LOADING PLATFORM.

The loading platform G is made of a channel iron inclosing it on all sides except the front, two bent channel irons which are bolted to the chassis, two middle ones which are braced to the latter by triangular pieces, and a flooring of plate iron. The bent channel irons constitute the support of the platform forming the pivot of the rollers at the bottom and being bolted to the chassis at the top. A railing surrounds the platform and a stepladder leads up to it on the right side.

THE CRADLE.

The cradle consists of two parts, a recoil and a nonrecoil part.

The nonrecoil part comprises two side beams, H, a front sleeve, I, rear sleeve, J, and a piston and rod, K. The side beams are of forged steel, bolted to the front and rear sleeves. The front sleeve is of cast steel, and carries on each side leather buffers to take up the shock of counter recoil. The rear sleeve is of forged steel and is prolonged beneath to form a crosshead for the piston rod. The inlet tube from the pump enters the left side of this crosshead. The piston M is forged with its rod. Its center is hollow and pierced with holes for the passage of the liquid. A valve closes these holes during the return to battery and permits of their opening during recoil. Notches cut in the edges of the valve permit the flow of liquid from the rear to the front of the cylinder during the return to battery.

The piston rod is connected to the rear sleeve by a supporting ring in front and a tension screw in rear of the sleeve. The opening through the piston is composed of two parts, one for a continuation of the inlet tube from the pump, and the other and larger a guide for the throttling bar N.

The recoil part of the cradle consists of a hydraulic cylinder of cast steel forming one piece with a sleeve, L (Pl. X). This sleeve is secured to the gun by being held between front and rear collars fixed on the jacket. The gun is prevented from rotating by having interruptions on the sleeve and front collar engaged with one another. The sleeve has four clips with bronze linings which embrace the upper and lower extremities of the side beams and slide on them during recoil. The hydraulic brake and recuperating system comprises, besides the piston and valve, the hydraulic cylinder, a throttling bar, and the recuperator.

The hydraulic cylinder has in front a screw bushing in which is screwed the throttling bar; on top air and filling holes; on bottom a drainage hole; and at the rear two lugs, which act as shoulders for the Belleville springs, and having openings for the passage of the rods P.

The throttling bar N is of a variable cross section, and is intended to regulate the flow of the liquid through the holes in the piston. It is screwed into the front part of the cylinder, and has on its rear portion a bronze jacket which works in the larger hole in the piston rod. To permit flow of liquid from the inlet tube, the exterior surface of the bronze jacket is grooved.

The recuperator is composed of a movable head, R, having two lugs against which bear a series, S, of Belleville springs. The same series of springs is supported in front against a shoulder on the rods P. A second series, S^1, of Belleville springs is placed on the same rods, and supported in front by the lugs on the movable head and in rear on the rods by washers and nuts.

During recoil the hydraulic cylinder moves back with the gun, displacing liquid from the front to the rear of the cylinder. The rear portion of the cylinder has not sufficient volume, due to the advance of the piston rod, to hold the displaced liquid, and in consequence the movable head R is forced out, compressing both sets of Belleville springs. After the fire, the increased tension on the springs forces the gun into battery.

A pump placed on the right cheek of the chassis can be used to fill the cylinder and increase the tension on the Belleville springs.

THE SHIELD.

The shield consists of a front plate, two side plates, and a top plate, riveted to each other by angle irons. It is secured by plates bolted at the sides and front to ribs on the chassis. It is provided with openings for the gun and the line of sight.

THE TRAVERSING MECHANISM.

The traversing mechanism comprises a horizontal shaft, S, having a handwheel at one extremity, and at the other a worm which engages in a worm wheel on the vertical shaft *t*. This worm wheel is connected with its shaft by alternating bronze and steel friction plates tightened by a clamp nut on the same axis, the bronze plates being keyed to the worm wheel and the steel plates to the shaft. In case of a sudden jar to the chassis, these plates permit of a slight movement among themselves, and thus prevent injury to the mechanism. The vertical shaft has on its lower extremity a pinion which engages in a circular rack on the base ring. The chassis traverses on alternating spherical rollers of two different diameters. It rests on the larger, which are kept in position by contact with the smaller.

ELEVATING MECHANISM.

The elevating gear is placed on the left of the chassis and has its bearings on a bracket attached to it. It consists of handwheel, the axis of which has at its other extremity a bevel wheel which engages with a corresponding one on a shaft parallel to the chassis. This shaft carries a worm which engages in a worm wheel on a shaft perpendicular to the chassis. This shaft carries a pinion which engages in a rack on the left side beam of the cradle. Nearly all the parts described are inclosed in the casing V (Pl. IX). The handwheels for traversing and elevating are placed so as to be readily actuated by the gun layer.

SIGHTS.

(Plate XI.)

The breech sight consists of a bar, a crosspiece, sliding collar, and drift corrector. The bar A is octagonal in cross section and one of its sides constitutes a rack in which engages a pinion for working the bar. The rear face of the bar is a scale of equal parts reading to millimeters.

The crosspiece carries the peephole, and is graduated to correct for drift, speed of the target, and the wind. It is composed of two hollow cylinders one within the other, and having the upper surfaces of both cut away, a peephole, and screws for working the inner cylinder and the peephole. The outer cylinder *a* is automatically deflected for drift. On it are drift and speed scales. The inner cylinder *b* is deflected by a screw operated by the right milled head, and corrects for speed according to the scale on the outer cylinder. The inner cylinder has a scale to correct for wind. The peephole is deflected by a screw with milled head and corrects for wind according to the scale on the inner cylinder. The deflecting of the outer cylinder carries with it the inner cylinder and the peephole, and that of the inner cylinder the peephole. Thus the separate corrections for drift, speed of target, and wind are applied independently, and the total deflection of the peephole is the additive result of these corrections.

The sliding collar C, in which slides the bar and drift corrector, is provided with a milled head and pinion for working the bar, two clamp screws, one for working the bar and the other for the drift corrector, and a bracket for the electric lamp. The collar is secured to a socket on the left side beam of the cradle. The drift corrector is a vertical rod having a pinion at its upper extremity which engages in a rack on the outer cylinder of the crosspiece. The rod is provided with a helical groove, in which works a stud. As the rod moves, vertically, it is constrained to rotate so that the groove and stud are always in the same vertical plane. This rotation of the rod gives, by the pinion and rack, the correction for drift to the outer cylinder. The front sight E is supported on the left trunnion, and consists of a ring having four radial pieces projecting inward to form the point. A bracket is provided for the electric lamp.

For use at night electric lamps (Pl. XIII) are fitted in brackets under the sights. These lamps are exceedingly small, and are almost completely inclosed by a metal covering, light being permitted to shine on the sights through a very minute opening. A portion of the covering can be unscrewed from each lamp, as shown in the photograph. A combined rheostat and switch, R, and a battery complete the lamp circuit.

AMMUNITION.

(Plate XII.)

The ammunition furnished with gun is fixed. The case is a solid drawn-brass case, having a conical body and cylindrical neck. The liability of accident is reduced to a minimum by having a primer which is screwed into its hole prior to firing. This screw primer can be removed at any time and its place taken by an ordinary screw plug.

The weight of the projectile is 46.2 pounds, and the powder charge 11 pounds of B. N. smokeless powder. The total weight of the case complete is about 73 pounds. The plate shows the relative sizes of the loaded case, projectile, and powder charge.

The programme adopted for the test of the 4.72-inch rapid-fire guns is as follows:

Each gun to be carefully examined by the Board. The number of parts of the breech mechanism in each, their strength, simplicity, and certainty of action to be noted; also the ease, safety, and certainty of the breech mechanism as a whole. Note especially the action of the firing pin and extractor and the maximum outward position of the cartridge when it can be pushed home by the breechblock. During this examination 20 rounds to be fired at will from each gun.

VELOCITY.

Five rounds to be fired for velocity from each gun with full charges.

ACCURACY.

Ten rounds to be fired at each range of 1 mile and 3,000 yards; the same conditions of aiming being repeated at each round with the guns, respectively, and the mean deviations determined.

RAPIDITY.

Determine the number of rounds that can be fired in 3 minutes, noting carefully during the firing, and especially at the termination of the test, the condition of the guns as regards heat and ease and certainty of action.

Two detachments of men to be used, the first to be relieved in 1 minute 30 seconds.

The above test to be repeated if found necessary by the Board.

RAPIDITY WITH ACCURACY.

Fire 10 aimed shots as rapidly as possible at the 1,000-yard and 1-mile targets; also 10 aimed shots at targets in same line and at ranges of 500 yards and 1,000 yards alternately; also 10 aimed shots alternately at targets at about 500 yards range, placed about 75 feet apart.

TEST OF SHRAPNEL.

Against steel plates.—Two shrapnel of each kind to be fitted with Frankford Arsenal sensitive-point fuses, and fired to burst while passing through a screen placed in front of a 1½-inch rolled-steel plate located about 150 feet from the gun; the effect on the plate of the fragments to be noted. The charge in above test to be such as to give a muzzle velocity equal to the remaining velocity at 1 mile when full charges are used.

For dispersion.—Three shrapnel of each kind to be fitted with Frankford Arsenal sensitive-point fuses and fired to burst while passing through a screen placed about 100 feet in front of the 1,000-yard target, and the number of hits and their character as regards penetration, etc., to be observed.

CANISTER.

Two canister of each kind to be fired against a 1½-inch rolled-steel plate, to be located about 300 yards from the gun, and effects on the plate to be noted Also two canister of each kind to be fired against a screen 26 by 20 feet, located about 100 yards from the gun; the number of hits at each round to be noted.

RAPIDITY WITH ACCURACY AGAINST A MOVING TARGET.

A boat on which is placed a suitable target to be towed across the line of fire at the rate of about 6 miles an hour. While within ranges of from 500 to 2,000 yards, each gun to be fired aimed shots as rapidly as possible for 3 minutes. The number of hits to be noted.

DUST.

The mechanism of each gun to be exposed to a blast of fine dust in such manner as to insure its being uniformly and equally covered with the dust, after which 20 rounds to be fired from each gun as rapidly as possible.

RUST.

Five rounds to be fired after the mechanism of each gun has been rusted in a thorough and uniform manner.

EXCESSIVE CHARGES.

Each gun to be fired 5 charges with gradually increasing pressures, the maximum being about 33⅓ per cent above the service pressure.

DEFECTIVE CARTRIDGES.

Each gun to be tested with defective cartridges in the same manner as is usual in the trial of small arms.

ENDURANCE.

The guns which successfully pass the above test to be fired 100 rounds for endurance, during which the general efficiency of the gun and its mount, also the regularity of action of the fuses, will be carefully observed.

If at any time during the test a gun shows a marked inferiority as compared with the others, the test of this gun will be suspended.

The test in accordance with the above programme was commenced November 21, 1894.

The action of the mechanism in manipulation and deliberate firing was satisfactory. The number of parts of the mechanism is 39, including 4 springs. This number, though not excessive, is considered greater than is consistent with the simplicity and certainty of action required in a rapid-fire gun. The extractor has little surplus power over that required under normal conditions, and a separate tool is provided for the extraction of cases which have stuck in the chamber. This feature results in a tendency to overstrain, and therefore to bend and distort, the extractor before it is discovered that use must be made of this tool. The action of the extractor under normal conditions is simply to loosen the case, after which the latter is withdrawn by hand. At the termination of the operation of closing the block, the right arm of the operator, as well as a considerable portion of his body, is in rear of the breech of the gun. This is considered by the Board a very objectionable feature in a rapid-fire gun, as it might easily happen in the excitement of rapid firing that the piece would be discharged after the block is closed, but before the operator has time to get out of the way. In this event the latter would be seriously injured by the blow due to the recoil of the piece. The safety of the mechanism from premature explosion is secured by means of a safety pin which works in a cylindrical opening in the bronze support and into the breech screw. Only when the recess in the screw is exactly opposite the opening in the bronze support, i. e., when the block is closed and locked, can the safety pin actuate the hammer and fire the gun. The three motions of rotating, withdrawing, and swinging the block are accomplished by a single motion of the lever. This arrangement adds considerably to the complexity and number of parts to the system; the single motion is necessarily through an arc having a large radius; very little is therefore gained in either efficiency or rapidity over a swinging block system in which the opening of the block is effected by two or three relatively much shorter motions.

VELOCITY.

The greatest velocity obtained in January, 1895, was 2,131 feet per second, pressure 34,200 pounds per square inch, the charge being 10 pounds 8 ounces of the B. N. smokeless powder. By July of the same year the ballistic qualities of this powder had materially changed, a charge of 10 pounds 7 ounces giving as high a pressure as 42,778 pounds, the velocity being 2,260 feet per second. Both pressure and velocity for the same charge varied to such an extent that the powder was not considered suitable for use in the accuracy tests. Experiments were therefore made with cordite, which was found to be much better for the gun than the B. N. The charge adopted was 8 pounds 4 ounces, the mean velocity with three rounds being 2,470 feet per second, pressure about 34,000 pounds.

RAPIDITY.

For safety in this test the charge was reduced to 7 pounds of B. N. powder; with this charge the pressure would probably not exceed about 16,000 pounds. A temporary platform was erected in rear of the gun platform and on a level with it. On this platform was placed the fixed ammunition. The gun detachment consisted of two officers and five enlisted men. One officer operated the breechblock and the other pointed the gun and fired. No. 1 of the enlisted men, standing on the right of the breech, received the cartridges from No. 2, inserted them in the chamber, removed the fired cases from the chamber and passed them to No. 3. No. 2, standing on the temporary platform, passed the cartridges to No. 1. No. 3, standing on the ground, received the empty cases from No. 1 and passed them to No. 4, who laid them carefully on the ground. No. 5, standing on the ground near the temporary platform, rolled the cartridges to within easy reach of No. 2. At the end of the first minute 4 rounds had been fired, at the end of the second minute 9 rounds, and at the third minute 18 rounds; two missfires, at the second and seventh rounds, respectively, were counted as fired rounds. The missfires affected the rapidity to the extent of one or possibly two rounds. They appeared to be due to insensitive primers rather than to a lack of strength in the firing mechanism.

ACCURACY.

With the charge of cordite determined as above, targets were taken at 1 mile and 3,000 yards. At 1 mile the mean vertical deviation from the center of impact was 2.34 feet; mean horizontal deviation, 1.77 feet; mean deviation, 2.94 feet. At 3,000 yards the mean vertical deviation was 3.8 feet; mean horizontal deviation, 3.82 feet, and mean deviation, 5.42 feet.

The targets are shown on Pls. XIV and XV.

RAPIDITY WITH ACCURACY AT 1,000 AND 500 YARDS.

For safety the charge of cordite was reduced to 5 pounds 8 ounces, for which charge the velocity was determined to be 1,845 feet per second; pressure, 19,000 pounds. To compensate for this reduced velocity from that due to a full charge the ranges were reduced from 1 mile and 1,000 yards to 1,000 yards and 500 yards, respectively. The number and duties of the gun detachment were the same as in the rapidity test previously described, except that a noncommissioned officer operated the breech mechanism. For the 1,000-yard target two preliminary rounds were fired, the second of which was a missfire. The results were as follows: Mean vertical deviation from center of impact, 1.55 feet; mean horizontal deviation, 1.34 feet; mean deviation, 2.05 feet. Time for the ten rounds, 1 minute 59$\frac{1}{5}$ seconds. At 500 yards two preliminary rounds were fired. For this target the mean vertical deviation was 0.86 foot; mean horizontal deviation, 0.83 foot; mean deviation, 1.20 feet. Time for the ten rounds, 1 minute and 55 seconds, excluding a delay of 7 minutes and 20 seconds at the seventh round, caused by a missfire.

RAPIDITY WITH ACCURACY ALTERNATING AT TWO 500-YARD TARGETS, 75 FEET APART.

The gun detachment was the same in number and duties as in previous rapidity tests. The gun was aimed and firing conducted by Lieut. George Montgomery, Ordnance Department, the officer who had conducted all the rapidity and accuracy tests made with this gun. Prior to this firing, and on account of the missfires which had occurred, the firing pin, which had become somewhat burred on its edges and fitted rather loosely in its seat, was replaced by a new pin. At the second round, and while the man operating the mechanism was in the act of closing the block, a premature explosion occurred, resulting in the instant killing of two and wounding of the remaining four of the enlisted men belonging to the detachment working the gun. Full details of this accident are in the possession of the Department, furnished by the Board, and also by Lieut.-Col. F. H. Parker, Ordnance Department, who was specially detailed to investigate it. Careful examination showed that the premature explosion was undoubtedly caused by a faulty seating of the coned portion of the firing pin in the recess prepared for it in the breechblock, and although this firing pin was somewhat shorter than the pin used in previous firings, this faulty adjustment of the two coned surfaces caused the pin to protrude to a dangerous extent beyond the face of the breechblock, so that when the latter was quickly closed, as in a rapidity test, the protruded pin was enabled to strike the primer a blow sufficient to explode the cartridge before the block was closed. The difference in the amount of protrusion of the two pins was slight, but was sufficient to determine the difference between absolute safety and extreme danger.

The breech mechanism having been completely destroyed by this accident, the test of the gun and mount was closed.

The action of the mount throughout the test was satisfactory.

FRANK H. PHIPPS,
Major, Ordnance Department, U. S. A., President.
FRANK HEATH,
Captain, Ordnance Department, U. S. A.
J. C. AYRES,
Captain, Ordnance Department, U. S. A.
WILLIAM CROZIER,
Captain, Ordnance Department, U. S. A.

The CHIEF OF ORDNANCE, UNITED STATES ARMY,
Washington, D. C.

(4066—Enc. 16)

Record of firing with 4.72-inch Canét rapid-fire gun, at Sandy

[Object of firing, preliminary rounds to test action of

Date.	No. of fire.	Powder.			Projectile.		No. of case.	Elevation.	Instrumental velocity, 275 feet from muzzle.	Pressure per square inch of bore.	Recoil.
		Kind.	Weight.		Kind.	Weight.					
			Lbs.	*Ozs.*		*Pounds.*		°	*Feet.*	*Pounds.*	*Inches.*
1894. Nov. 22	1	French smokeless B. N.	....	....	Shell, lot 630.	46	....	....	....	5, 7,922	5⅝
Nov. 22	2		....	....		46	....	....	....	....	8
Nov. 22	3		....	....		46	....	....	....	....	8
Nov. 22	4		....	....	Canister, lot 632.	46	....	....	....	....	8
1895. Jan. 22	5		10	8 7 igniter.	Shell, lot 630.	46	....	....	2,128 2,130	5, 33,080	8½
Jan. 22	6		10	8 7 igniter.		46	....	....	2,042 2,044	5, less than 32,000	8½
Jan. 22	7		10	8 7 igniter.		46	....	....	2,084 2,088	5, 29,309	8½
Jan. 22	8		10	8½ 7 igniter.		46	....	....	2,066 2,068	10, 32,30	8½
Jan. 22	9		10	9½ 7 igniter.		46	....	....	2,088 2,092	28,527	8½
Jan. 22	10		10	9½ 7 igniter.		46	....	....	2,078 2,078	20, less than 28,000	8½
Jan. 22	11		10	8 7 igniter.		46	....	....	2,128 2,134	5, 34,200	8½
June 19	12		10	4 7 igniter.		46	....	....	....	....	....
June 19	13		10	4 7 igniter.		46	....	....	....	....	....
June 19	14		10	4 7 igniter.		46	....	....	....	....	....
July 17	15		10	0 7 igniter.		46	....	....	....	10, 27,382	8¼
July 17	16		10	0 7 igniter.		46	....	....	....	25, 31,491	8¼
July 17	17		10	4 7 igniter.		46	....	....	....	10, 35,717	8¼
July 17	18		10	4 7 igniter.		46	....	....	....	25, 41,289	8¼
July 17	19		10	4 7 igniter.		46	....	....	....	10, 33,244	8¼
July 18	20		10	4 7 igniter.		46	....	8	....	25, 35,767	8¾
July 18	21		10	4 7 igniter.		46	....	8	....	25, 33,927	8¾
July 18	22		10	6 7 igniter.		46	....	8	....	25, 37,320	8¾
July 18	23		10	6 7 igniter.		46	....	8	....	25, 34,569	8¾
July 18	24		10	6 7 igniter.		46	....	8	....	25, 37,340	8¾
July 18	25		10	6 7 igniter.		46	....	8	....	25, 34,200	8¾
July 18	26		10	7 7 igniter.		46	....	....	....	25, 34,446	8¾

Hook Proving Ground, from November 22, 1894, to August 9, 1895.

breech mechanism and determine charge and velocities.]

Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Inches.			
....	Wind from right and rear, 25°, 14 miles an hour; barometer, 30.43; thermometer, 49°; humidity, 67.	Uncompressed coppers of 1890	3½ gallons of glycerin in cylinder. 1 gallon of glycerin in receiver. The igniter used in all charges of B. N. powder was a black powder composed of cubical grains, the side of each cube being about ¼ inch in length. Firing conducted by Lieut. F. P. Peck, Ordnance Department, in the presence of the Ordnance Board. Present: Maj. F. H. Phipps, Ordnance Department; Capt. F. Heath, Ordnance Department; Capt. W. Crozier, Ordnance Department.
....		....	
....		....	
....		....	
....	Wind from right and rear, 30°, 18 miles an hour; baromeer, 29.65; thermomteter, 37°; humidity, 65.	24,000 coppers of 1890	The muzzle jumps up after each discharge. Firing conducted by Lieut. F. P. Peck, Ordnance Department, in the presence of the Ordnance Board. Present: Capt. F. Heath, Ordnance Department; Capt. W. Crozier, Ordnance Department.
....		32,000 coppers of 1890	
....		28,000 coppers of 1890, used in rounds 7 to 11, inclusive.	
....		....	
....		....	
....		....	
....		....	
....	Wind from left, 8 miles an hour; barometer, 30.11; thermometer, 79°; humidity, 57.	....	Firing conducted by Lieutenant Peirce, Ordnance Department. Present: Maj. F. H. Phipps, Ordnance Department; Capt. F. Heath, Ordnance Department; Capt. W. Crozier, Ordnance Department.
....		....	
....		....	
8 1/16	Wind from front, 7 miles an hour; barometer, 30.06; thermometer, 81°; humidity, 68.	24,000 coppers of 1890	1 quart of pure glycerin added. Firing conducted by Lieutenant Montgomery, Ordnance Department. Present: Capt. F. Heath, Ordnance Department.
8¼		24,000 coppers of 1890	
8¼		28,000 coppers of 1890	
8¼		28,000 coppers of 1890	
8¼		32,000 coppers of 1890	
....	Wind from front, 8 miles an hour; barometer, 30.12; thermometer, 83°; humidity, 55.	32,000 coppers of 1890	Firing conducted by Lieutenant Montgomery, Ordnance Department. Present: Maj. F. H. Phipps, Ordnance Department; Capt. F. Heath, Ordnance Department; Capt. W. Crozier, Ordnance Department.
....		32,000 coppers of 1890	
....		32,000 coppers of 1890	
....		32,000 coppers of 1890	
....		32,000 coppers of 1890	
....		32,000 coppers of 1890	
....		32,000 coppers of 1890	

Record of firing with 4.72-inch Canét rapid-fire gun, at Sandy Hook

[Object of firing, preliminary rounds to test action of

Date.	No. of fire.	Powder.			Projectile.		No. of case.	Elevation.	Instrumental velocity, 275 feet from muzzle.	Pressure per square inch of bore.	Recoil.
		Kind.	Weight.		Kind.	Weight.					
1895.			*Lbs.*	*Ozs.*		*Pounds.*		°	*Feet.*	*Pounds.*	*Inches.*
July 18	27	French smokeless B. N.	10	8 7 igniter.	Shell, lot 630.	46	......	......	....	25, 39,133	8¾
July 18	28		10	8 7 igniter.		46	......	......	....	25, 35,600	8¾
July 18	29		10	8 7 igniter.		46	......	......	....	25, 39,111	8¾
July 18	30		10	8 7 igniter.		46	......	......	....	25, 39,320	8¾
July 18	31		10	7 7 igniter.		46	......	......	....	25, 35,455	8¾
July 18	32		10	7 7 igniter.		46	......	......	....	25, 39,340	8¾
July 18	33		10	7 7 igniter.		46	......	......	....	25, 38,200	8¾
July 25	34		10	7 7 igniter.		46	1	......	2,118 2,148	5, 32,154	8½
July 25	35		10	7 7 igniter.		46	2	......	2,190 2,207	25, 33,483	8½
July 25	36		10	7 7 igniter.		46	1	......	2,205 2,200	5, 34,446	8¾
July 25	37		10	7 7 igniter.		46	2	......	Lost. 2,211	25, 34,840	8¾
July 25	38		10	7 7 igniter.		46	1	......	Lost. 2,260	5, 42,778	8½
July 25	39	Cordite, igniter of musketpowder.	5	8 1 igniter.		46	2	......	Lost. 1,862	25, 18,580	8
July 25	40		6	8 1½ igniter.		46	1	......	Lost. 2,132	25, 27,000	8¼
July 25	41		7	7 1½ igniter.		46	3	......	Lost. 2,301	5, 31,340	8½
July 25	42		8	0 1½ igniter.		46	1	......	Lost. 2,397	25	......
July 25	43		8	6 1½ igniter.		46	3	......	Lost. 2,466	25, 37,667	8½
July 25	44	French smokeless B. N.	7	0 7 igniter.		46	1	......	Lost. 1,569	25, 14,240	8¾
July 26	45	Cordite, igniter musketpowder.	8	4 1½ igniter.		46	1	......	2,458 2,443	25, 34,431	8¾
July 26	46		8	4 1½ igniter.		46	3	......	2,481 2,467	25, 36,862	8¾
July 26	47	French smokeless.	7	0 7 igniter.		46	4	......	1,638 1,655	25, 16,050	8¾
July 26	48		7	0 7 igniter.		46	3	......	1,612 Lost.	25, 14,885	8¾
July 27	49	Cordite, igniter musketpowder.	5	8 1 igniter.		46	3	......	1,839 1,831	25, 19,100	8¾
July 27	50		5	8 1 igniter.		46	4	......	1,857 1,853	25, 18,764	8¾

Proving Ground, from November 22, 1894, to August 9, 1895—Continued.

breech mechanism and determine charge and velocities.]

Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Inches.			
....	Wind from front, 8 miles an hour; barometer, 30.12; thermometer, 88°; humidity, 55.	32,000 coppers of 1890	Firing conducted by Lieutenant Montgomery, Ordnance Department. Present: Maj. F. H. Phipps, Ordnance Department; Capt. F. Heath, Ordnance Department; Capt. W. Crozier, Ordnance Department. Round 33: The trigger arm did not take proper position after firing; had to be pressed back by hand.
....		32,000 coppers of 1890	
....		32,000 coppers of 1890	
....		32,000 coppers of 1890	
....		32,000 coppers of 1890	
....		32,000 coppers of 1890	
....		32,000 coppers of 1890	
....	Wind from left, 6 miles an hour; barometer, 29.97; thermometer, 80°; humidity, 57.	Obturation good	Present: Maj. F. H. Phipps, Ordnance Department; Capt. F. Heath, Ordnance Department; Capt. W. Crozier, Ordnance Department. In charges of cordite over 5 pounds 8 ounces the cordite was inserted in the case in 2 bunches. In pound 8 ounce charges an igniter of ½ ounce was placed at the bottom of the case and another of ½ ounce occupied the center of the bunch. In charges over 5 pounds 8 ounces each bunch had a central igniter, making the total weight of the igniter 1½ ounces.
....		Obturation good	
....		Shell entered case rather easily. Obturation good.	
....		Obturation good	
....		Obturation good	
....		Shell entered case rather easily. Case dented on the outside.	
....		Two wads over powder	
....		Case used once before. Shell entered tightly.	
....		Primer failed to explode	
....	Wind from rear, 5 miles an hour; barometer, 30.04; thermometer, 83°; humidity, 60.	32,000 coppers of 1890	
....		14,000 coppers of 1892	
....	Wind from rear, 6 miles an hour; barometer, 30.03; thermometer, 80°; humidity, 44.	Case split near front end. 32,000 coppers of 1890.	Firing conducted by Lieut. W. S. Peirce, Ordnance Department, in the presence of the Ordnance Board. Present: Capt. F. Heath, Ordnance Department; Capt. W. Crozier, Ordnance Department.
....		32,000 coppers of 1890	
....		Missed fire once. 14,000 coppers of 1892.	
....		14,000 coppers of 1892	
....	Wind from rear, 8 miles an hour; barometer, 29.97; thermometer, 81°; humidity, 48.	18,000 coppers of 1892	
....		Small split near front end of case. 18,000 coppers of 1892.	

Record of firing with 4.72-inch Canét rapid-fire gun, at Sandy Hook

[Object of firing, to

Date.	No. of fire.	Powder.		Projectile.		No. of case.	Elevation.	Instrumental velocity, 275 feet from muzzel.	Pressure per square inch of bore.	Recoil.
		Kind.	Weight.	Kind.	Weight.					
			Lbs. Ozs.		*Pounds.*		°	*Feet.*	*Pounds.*	*Inches.*
1895. Aug. 5	51 to 67	French smokeless B. N.	7 0 7 igniter.	Shell, lot 630.	46	......	......	....	....	....

[Object of firing, to deter-

Date.	No. of fire.	Powder.		Projectile.		No. of case.	Elevation.	Instrumental velocity, 275 feet from muzzel.	Pressure per square inch of bore.	Recoil.
		Kind.	Weight.	Kind.	Weight.					
Aug. 9	68	Cordite, igniter of musket powder.	8 4 1½ igniter.	Shell, lot 630.	46	......	......	Lost.	25, less than 32, 000	8½
Aug. 9	69		8 4 1½ igniter.		46	......	......	2, 477 2, 464	25, 31, 824	8½
Aug. 9	70		8 4 1½ igniter.		46	......	......	2, 468 2, 460	25, 34, 055	8½
Aug. 9	71		8 4 1½ igniter.		46	......	......	2, 474 2, 474	25, 34, 267	8½

Proving Ground, from November 22, 1894, to August 9, 1895—Continued.

test gun for rapidity.]

Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Inches.			
....	Wind from rear and right, 30°, 11 miles an hour; barometer, 30.09; thermometer, 88°; humidity, 49.	Fired to locate the point of striking. All cases which were used before entered with difficulty. Number of rounds fired in 1 minute, 4. Number of rounds fired in 2 minutes, 9. Number of rounds fired in 3 minutes, counting missfires, 18. There were two missfires, viz, the second and seventh rounds.	To conduct the rapidity test, a temporary platform was erected in rear of the gun platform, and on a level with it. On this platform was placed the fixed ammunition. The gun detachment consisted of two officers and five men. One officer operated the breechblock and the other pointed the gun. No. 1, standing on the right of the breech, received the loaded cases from No. 2, inserted them in the chamber, removed the fired cases from the chamber, and passed them to No. 3. No. 2, standing on the temporary platform, passed the loaded cases to No. 1. No. 3, standing on the ground, received the empty cases from No. 1 and passed them to No. 4, who laid them carefully on the ground. No. 5, standing on the ground alongside the temporary platform, rolled the loaded cases to within easy reach of No. 2. Present: Maj. F. H. Phipps, Ordnance Department.

mine the charge of cordite.]

....	Wind from right, 7 miles an hour; barometer, 30.21; thermometer, 92°; humidity, 87.	32,000 coppers of 1890	Firing conducted by Lieut. W. S. Peirce, Ordnance Department.
....		28,000 coppers of 1890	
....		28,000 coppers of 1890	
....		28,000 coppers of 1890	

Record of firing with 4.72-inch Canét rapid-fire gun at Sandy

[Object of firing, to

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Pressure per square inch of bore.	Deflection, points left.	Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.					
1895.			*Lbs. Oz.*		*Pounds.*	° ′			*Inches*	
Aug. 26	72	Cordite, 1¼-ounce igniter of musket powder.	8 4	Shell, lot 630.	46	1 5	....	2	8¾	Wind from front, 11 miles an hour; barometer, 30.26; thermometer, 78°; humidity, 67.
Aug. 26	73		8 4		46	1 5	....	2	8¾	
Aug. 26	74		8 4		46	1 5	....	2	8¾	
Aug. 26	75		8 4		46	1 5	....	2	8¾	
Aug. 26	76		8 4		46	1 5	....	2	8¾	
Aug. 26	77		8 4		46	1 5	....	2	8¾	
Aug. 26	78		8 4		46	1 5	....	2	8¾	
Aug. 26	79		8 4		46	1 5	....	2	8¾	
Aug. 26	80		8 4		46	1 5	....	2	8¾	
Aug. 26	81		8 4		46	1 5	....	2	8¾	
Aug. 26	82		8 4		46	1 5	....	2	8¾	

[Object of firing, to test gun

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Elevation.	Pressure per square inch of bore.	Deflection, points left.	Recoil.	Wind, strength and direction.
Sept. 20	83	Cordite, 1¼-ounce igniter of musket powder.	8 4	Shell, lot 630.	46	2 4	....	....	8¾	Wind from rear, 12 miles an hour; barometer, 30.14; thermometer, 78°; humidity, 71.
Sept. 20	84		8 4		46	2 15	....	....	8¾	
Sept. 20	85		8 4		46	1 40	....	....	8¾	
Sept. 20	86		8 4		46	1 50	....	....	8¾	
Sept. 20	87		8 4		46	1 57	....	....	8¾	
Sept. 20	88		8 4		46	2 0	....	....	8¾	
Sept. 20	89		8 4		46	2 0	....	....	8¾	
Sept. 20	90		8 4		46	2 0	....	....	8¾	
Sept. 20	91		8 4		46	2 0	....	....	8¾	
Sept. 20	92		8 4		46	2 0	....	....	8¾	
Sept. 20	93		8 4		46	2 0	....	....	8¾	
Sept. 20	94		8 4		46	2 0	....	....	8¾	
Sept. 20	95		8 4		46	2 0	....	....	8¾	
Sept. 20	96		8 4		46	2 0	....	....	8¾	
Sept. 20	97		8 4		46	2 0	....	....	8¾	

Hook Proving Ground, from August 26 to September 28, 1895.

test accuracy at 1 mile.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
....	Aimed at center of target. Round 72: Some difficulty to remove case. Round 74: Some difficulty to remove case. Round 75: Primer exploded at second attempt. Round 77: Two attempts to fire and 3 to extract case. During the firing difficulty was experienced in starting the maneuvering lever prior to opening the block. The lever also failed by ordinary working of it to completely rotate the block into its locked position. Examination of the breech-block showed— (1) A slight burring of the corners of the threads and a grooving by the latter of the lowest plane sector. (2) A bending of the extractor and a burring of its front edge. (3) A lack of centering of the block. The breech mechanism was dismounted after this firing and no other defects than those noted above were visible. The extractor was straightened and the burring on the threads removed. The breech mechanism upon being mounted worked perfectly. The lack of centering of the block was not remedied. The difficulty experienced in working the block was mainly due to the bending of the extractor. Firing conducted by Lieutenant Montgomery, Ordnance Department. Present: Capt. F. Heath, Ordnance Department.

TARGET.

From center of target.				From center of impact.			
Vertical.		Horizontal.		Vertical.		Horizontal.	
Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.
7	......	......	3.5	3.829	......	......	0.617
3.5	......	......	0.833	0.329	......	2.050	......
0.542	......	......	1	......	2.629	1.883	......
5.5	......	......	7.833	2.329	......	......	4.950
3.823	......	......	6.083	0.662	......	......	3.2
2	......	......	1.917	......	1.171	0.966	......
......	2.25	......	2.167	......	5.421	0.716	......
6.5	......	......	1.5	3.329	......	1.383	......
0.667	......	......	3	......	2.504	......	0.117
4.417	......	......	1	1.246	......	1.883	......

Center of impact:	Feet.
Above	3.171
Left	2.883
Mean vertical deviation from center of impact	2.345
Mean horizontal deviation from center of impact	1.777
Mean deviation from center of impact	2.942

for accuracy at 3,000 yards.]

Special remarks	General remarks.
Struck 200 yards beyond......................... Struck 250 yards beyond......................... Could not be located............................. Struck short....................................... Struck 15 yards in front and on line............	Aimed at a flag planted 500 yards from gun. Target not visible from gun. The breech mechanism worked with the greatest facility throughout the firing. Firing conducted by Lieutenant Montgomery, Ordnance Department. Present: Maj. F. H. Phipps, Ordnance Department; Capt. F. Heath, Ordnance Department; Capt. W. Crozier, Ordnance Department.

TARGET.

From center of target.				From center of impact.			
Vertical.		Horizontal.		Vertical.		Horizontal.	
Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.
11	......	13	......	8	......	1.35	......
......	5	0		......	8	......	11.65
......	5	13	......	......	8	1.35	......
9.5	......	14.5	......	6.5	......	2.85	......
2	......	8	......	......	1	......	3.65
1	......	17.5	......	......	2	5.85	......
5	......	17	......	2	......	5.35	......
3.5	......	9.5	......	0.5	......	......	2.15
5	......	14	......	2	......	2.35	......
3	......	10	......	......	0		1.65

Center of impact:	Feet.
Above	3
Right	11.65
Mean vertical deviation from center of impact	3.8
Mean horizontal deviation from center of impact	3.82
Mean deviation from center of impact	5.419

Record of firing with 4.72-inch Canét rapid-fire gun at Sandy Hook

[Object of firing, to test gun for

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Pressure per square inch of bore.	Deflection, points left.	Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.					
			Lbs. Oz.		*Pounds.*	° ′			*Inches.*	
1895. Sept. 21	98 to 110	Cordite, igniter of musket powder.	5 8 1½ igniter.	Shell, lot 630.	46	0 56	....	....	....	Wind from rear, 6 miles an hour; barometer, 30.27; thermometer, 97°; humidity, 38.

[Object of firing, to determine whether the exposure to the

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Pressure per square inch of bore.	Deflection, points left.	Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.					
Sept. 24	111	Cordite, igniter of musket powder.	5 8 1 igniter.	Shell, lot 630.	46	....	25, less than 18,000	....	....	Wind from rear, 8 miles an hour; barometer, 30.08; thermometer, 80°; humidity, 62.
Sept. 24	112		5 8 1 igniter.		46	....	25, 16,444	....	....	
Sept. 24	113		5 8 1 igniter.		46	....	25, 17,178	....	....	
Sept. 24	114		5 8 1 igniter.		46	....	25, 16,207	....	....	

Proving Ground, from August 26 to September 28, 1895—Continued.

rapidity with accuracy at 1,000 yards.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
TARGET. (see below)	Two trials were made before the test was completed. During the first trial the first round was fired without any difficulty. After repeated attempts the second round proved a miss fire. Owing to the delay experienced in removing this round from the chamber the second trial had to made. The gun detachment was the same as that used in the "rapidity test," except that a noncommissioned officer performed the duties of the officer who operated the breech mechanism. The position and duties of the remaining cannoneers were identical. Firing conducted by Lieutenant Montgomery, Ordnance Department. Present: Maj. F. H. Phipps, Ordnance Department; Capt. F. Heath, Ordnance Department; Capt. W. Crozier, Ordnance Department.

TARGET.

No. of round.	From center of target.				From center of impact.			
	Vertical.		Horizontal.		Vertical.		Horizontal.	
	Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.
101	1	.....	.....	1	......	2.45	.....	0.9
102	6	.....	0		2.55	......	0.1	.....
103	1	.....	4	.....	......	2.45	4.1	.....
104	2	.....	0		......	1.45	0.1	.....
105	4	.....	0		0.55	......	0.1	.....
106	5	.....	0		1.55	......	0.1	.....
107	5	.....	2	.....	1.55	......	2.1	.....
108	5	.....	0		1.55	......	0.1	.....
109	2.5	.....	.....	2	......	0.95	.....	1.9
110	3	.....	.....	4	......	0.45	.....	3.9

Center of impact:	Feet.
Above	3.45
Left	0.1
Mean vertical deviation from center of impact	1.55
Mean horizontal deviation from center of impact	1.84
Mean deviation from center of impact	2.049

Time, 1 minute 59½ seconds.

sun of the fixed ammunition deteriorated the powder.]

....	This firing was undertaken with fixed ammunition, which had been exposed to the sun for a part of an afternoon, causing it to be suspected of deteriorating in consequence. The exposure was on the afternoon of September 21, when the thermometer registered 97° F. The time of exposure was about 2 hours. The powder was inspected and no evidence of exudation of nitroglycerin was apparent. When compared with powder not exposed it showed no dissimilarity. Four rounds of the ammunition were then fired with the results herein tabulated. Firing conducted by Lieut. G. Montgomery, Ordnance Department. Present: Capt. W. Crozier, Ordnance Department.

cf firing with 4.72-inch Canét rapid-fire gun at Sandy Hook

[Object of firing, to test accu-

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Pressure per square inch of bore.	Deflection, points left.	Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.					
			Lbs. Oz.		*Pounds.*	° '			*Inches.*	
1895. Sept. 27	115	Cordite, 1-ounce igniter.	5 8 1 igniter.	Shell, lot 630.	46	0 26				Wind from right and rear, 30°, 10 miles an hour; barometer, 30.07; thermometer, 74°; humidity, 33.
Sept. 27	116 to 126		5 8 1 igniter.		46	*mm.* 33				

[Object of firing, to test accuracy with rapidity at two 500-yard

Date.	No. of fire.	Powder Kind.	Powder Weight.	Projectile Kind.	Projectile Weight.	Elevation.	Pressure per square inch of bore.	Deflection, points left.	Recoil.	Wind, strength and direction.
Sept. 28	127	Cordite, igniter of musket powder.	5 8 1 igniter.	Shell, lot 630.	46	*mm.* 34				Wind from right and rear, 30°, 11 miles an hour; barometer, 30.20; thermometer, 78°; humidity, 84.
Sept. 28	128		5 8 1 igniter.		46	34				

Proving Ground, from August 26 to September 28, 1895—Continued.

racy with rapidity at 500 yards.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.									General remarks.
TARGET.									
No. of round.	From center of target.				From center of impact.				
	Vertical.		Horizontal.		Vertical.		Horizontal.		
	Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.	
117	0.5	.....	1.5	....	1.95	.....	0.967	.....	Rounds 115 and 116, sighting shots. The gun detachment consisted of 1 officer, 1 noncommissioned officer, and 5 men. Their positions and duties are the same as described under the "Rapidity with accuracy test" at 1,000 yards. Firing conducted by Lieutenant Montgomery, Ordnance Department. Present: Capt. F. Heath, Ordnance Department; Capt. W. Crozier, Ordnance Department.
118	....	0.5	0.5	....	0.95	.....	......	0.033	
119	....	0.5	......	2	0.95	.....	......	2.533	
120	....	1	0		0.45	.....	......	0.533	
121	....	1.5	......	0.5	....	0.05	......	1.033	
122	....	1.5	0.5	....	....	0.05	......	0.033	
123	....	2	0.666	....	....	0.55	0.133	.....	
124	....	2.5	0.666	....	....	1.05	0.133	.....	
125	....	2.5	2	....	....	1.05	1.467	.....	
126	....	3	2	....	....	1.55	1.467	.....	

Center of impact:	Feet.
Below	1.45
Right	0.533
Mean vertical deviation from center of impact	0.86
Mean horizontal deviation from center of impact	0.833
Mean deviation from center of impact	1.197

Time, 1 minute 55 seconds.

After the fifth round the primer failed, causing a delay of 7 minutes 20 seconds to remove the projectile.

targets, 75 feet apart, alternating shot by shot on targets.]

GENERAL REMARKS.

The gun detachment consisted of 1 officer, 1 noncommissioned officer, and 5 men. Their positions and duties are the same as described under the "Rapidity with accuracy test at 1,000 yards."

Prior to this firing, and due to missfires on previous occasions, it was decided to replace the firing pin by a new one. Comparison by the eye of the new pin with the old one showed no evidence that the old one had been blunted, and it was decided to replace the old one. Subsequently it was found that the old one was burred on the edges and fitted tightly in its bearings, and it was replaced by the new one, which fitted loosely.

While inserting the second loaded case a premature explosion took place, killing Corporal Doyle and Private Conway, who were stationed, respectively, on the left and right of the breech, and wounding Privates McDonald, Coyne, and Ryan, who were stationed in rear of the gun.

The breech mechanism was completely demolished, the breechblock blown to the rear about 260 feet, striking some cast-iron pieces, and subsequently passing through the machine shop into the carpenter shop, where it was found.

The case was broken off at the rim. The head of it was blown through the carpenter shop and found directly in rear of it.

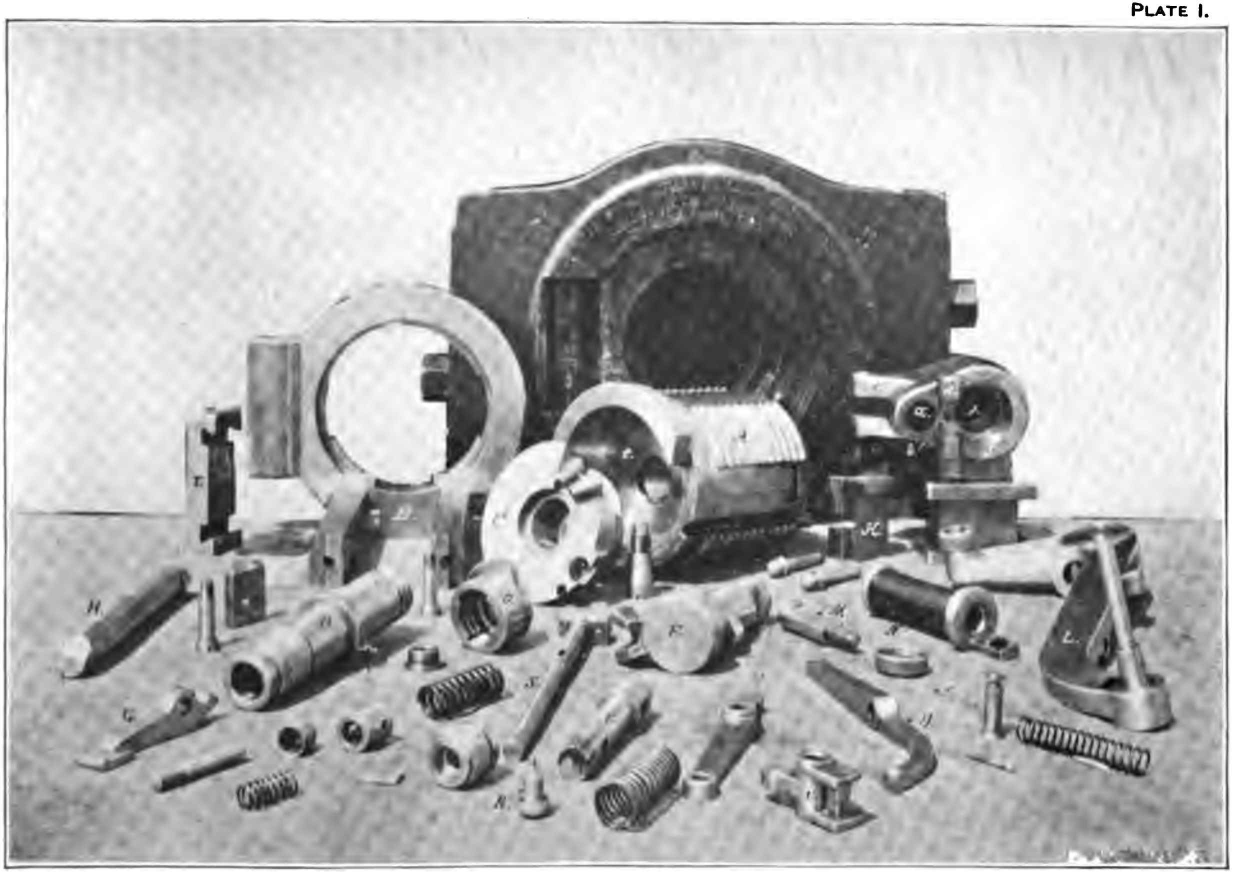
The cause of the accident was an ill-fitting firing pin. The cone on the pin did not seat properly in its bearing in the breechblock, causing the pin to protrude and fire the primer while the loaded case was being pushed into the chamber.

Firing conducted by Lieut. G. Montgomery, Ordnance Department, in the presence of the Ordnance Board. Present: Capt. F. Heath, Ordnance Department; Capt. W. Crozier, Ordnance Department.

For the Board: Frank H. Phipps, Major, Ordnance Department, U. S. A., president.

George Montgomery, Lieutenant, Ordnance Department, U. S. A., assistant proof officer.

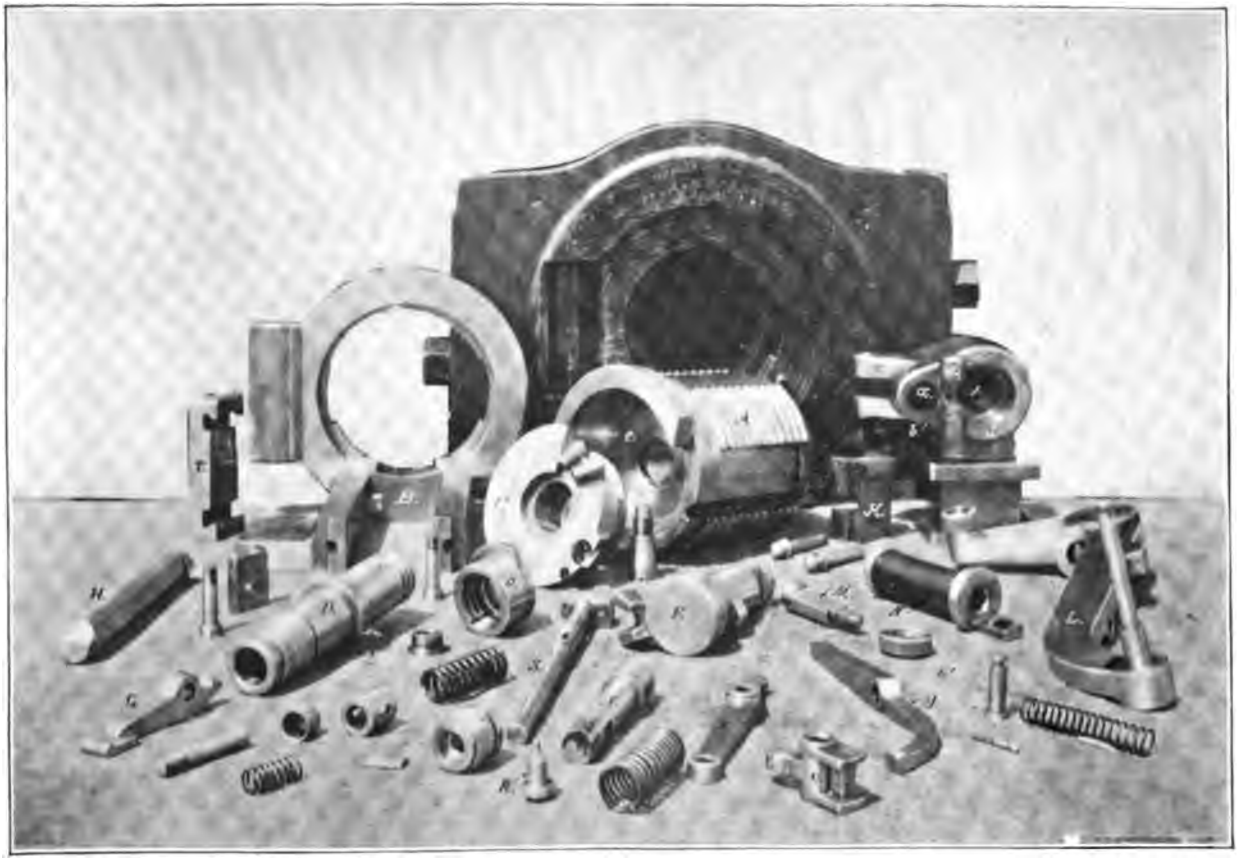
PLATE I.



Appendix 23. 1896.

PARTS OF BREECH MECHANISM. CANÉT 4.7-INCH R. F. GUN.

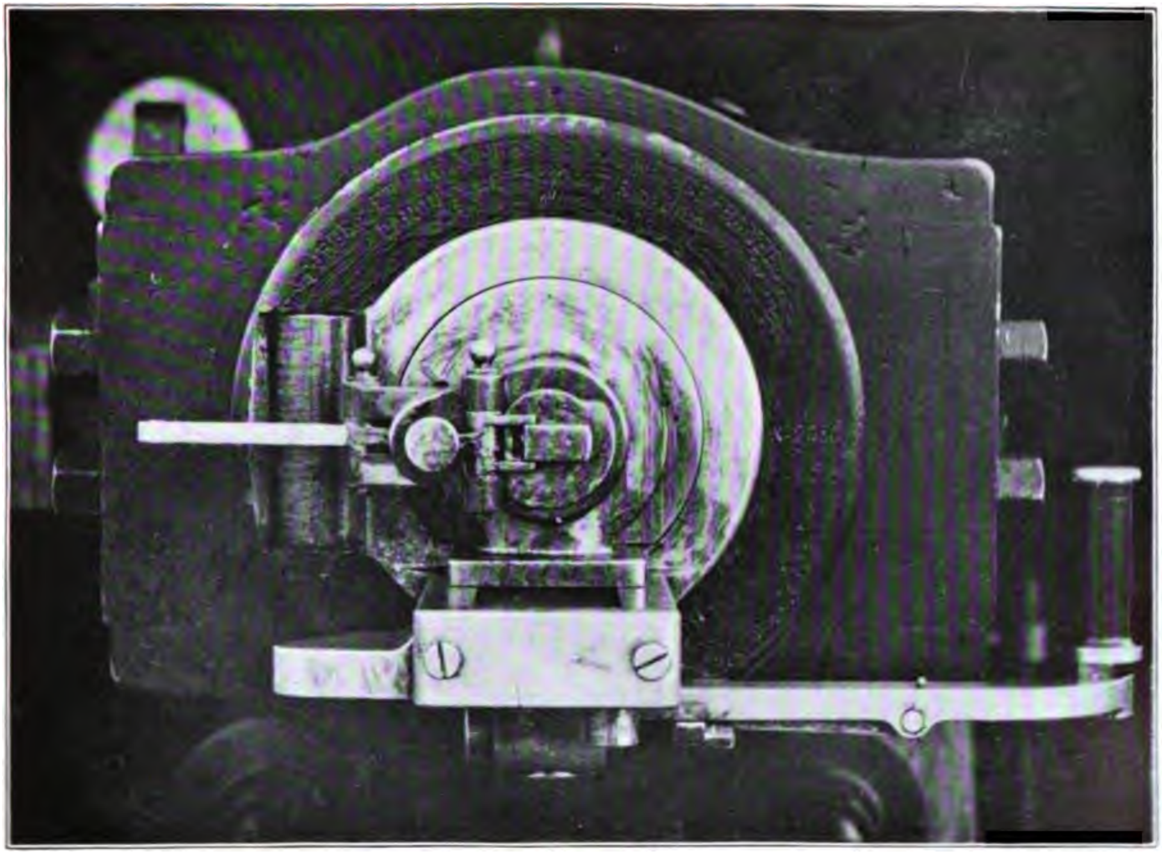
PLATE I.



Appendix 23, 1896.

PARTS OF BREECH MECHANISM. CANÉT 4.7-INCH R. F. GUN.

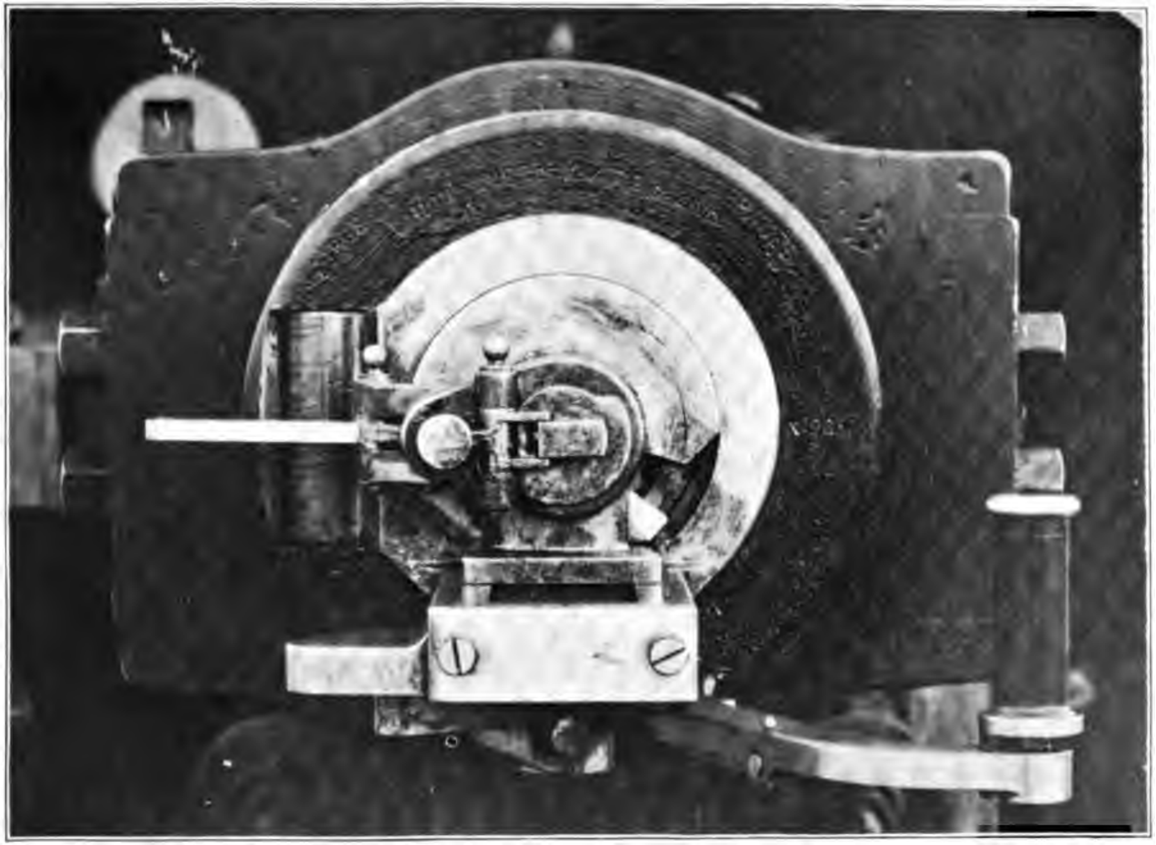
PLATE II.



Appendix 2, 1896.

BREECH MECHANISM LOCKED. CANET 4.7-INCH R. F. GUN.

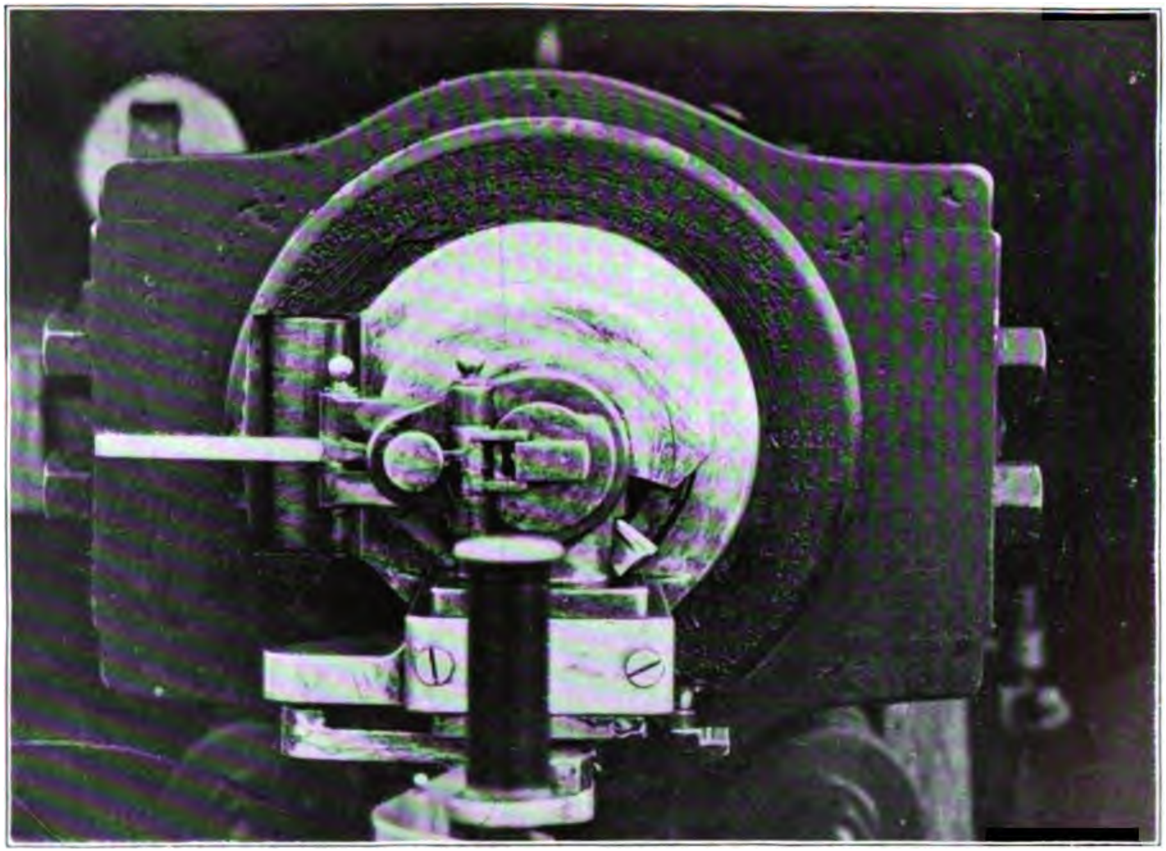
Plate III.



Appendix 23, 1896.

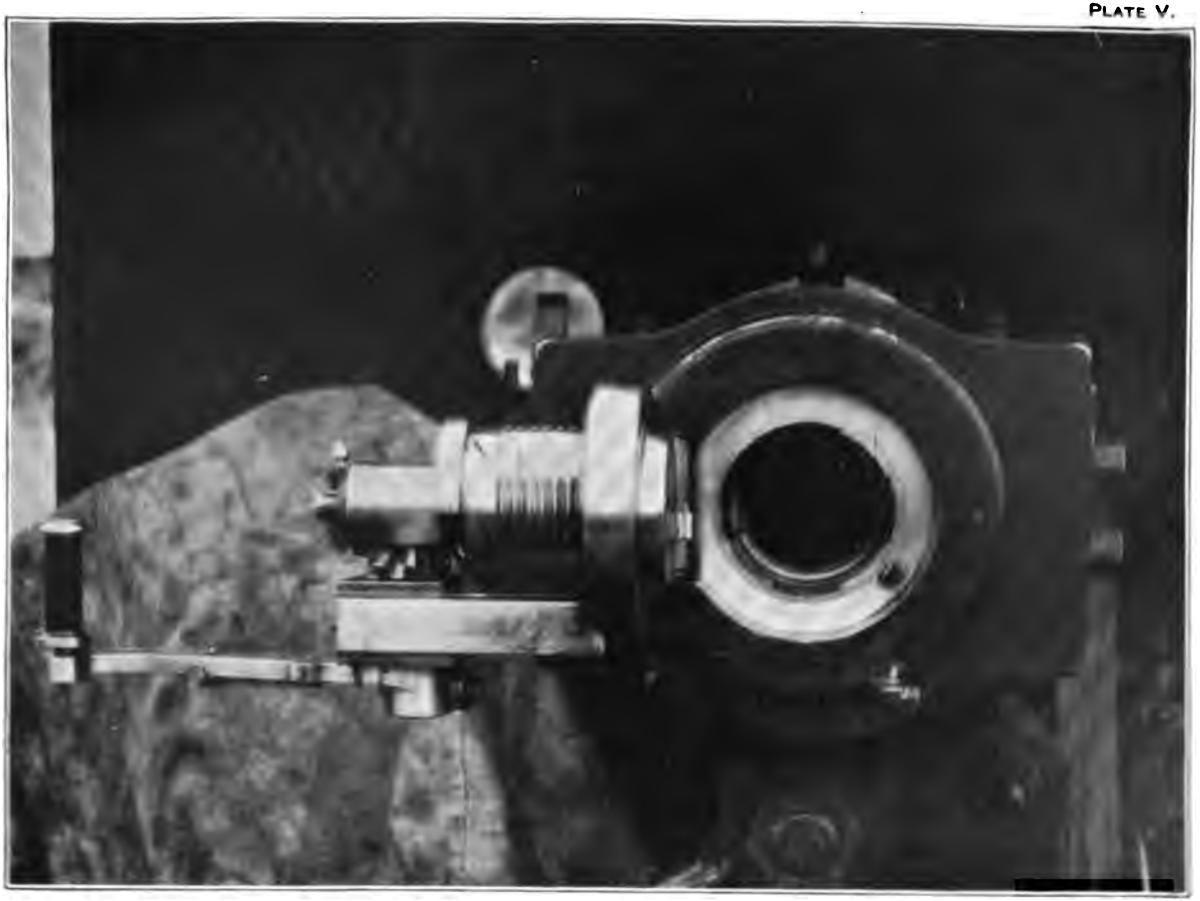
Breech Mechanism rotated. Canét 4.7-inch R. F. Gun.

Plate IV.



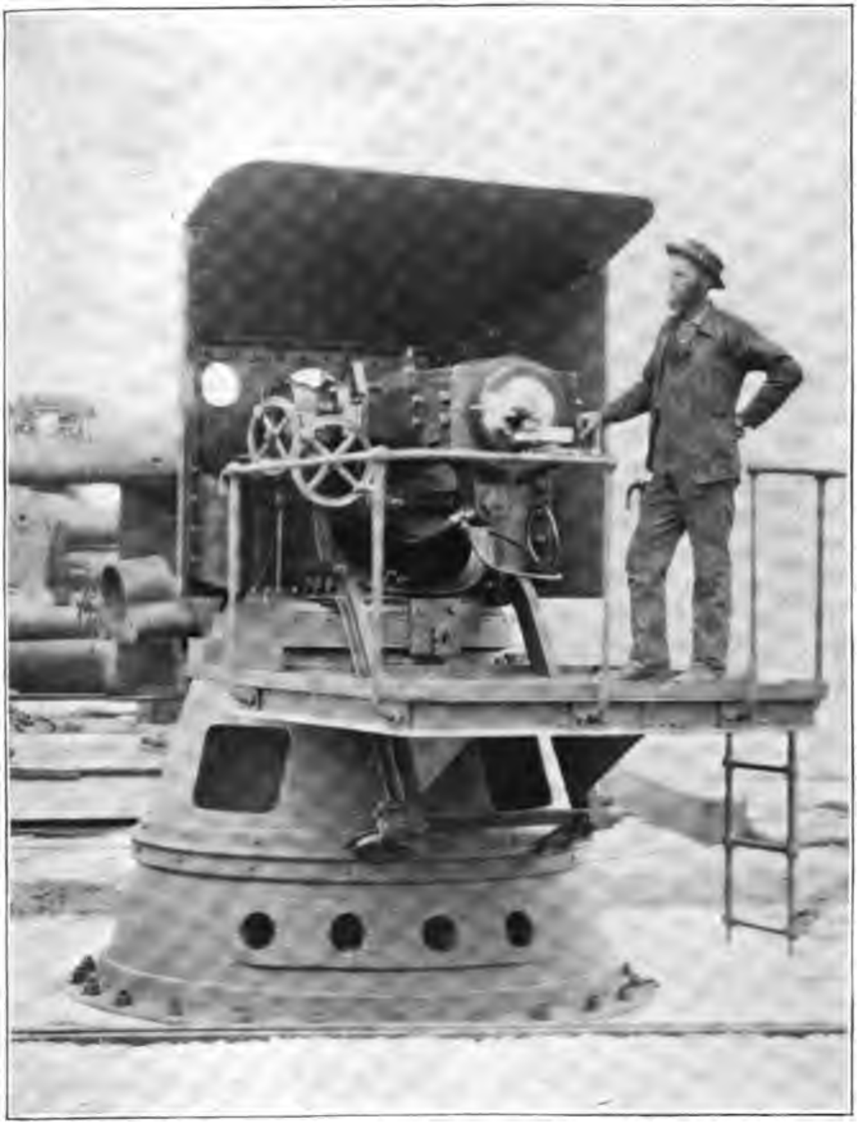
Appendix 23, 1896.

Breech Mechanism withdrawn. Canét 4.7-inch R. F. Gun.

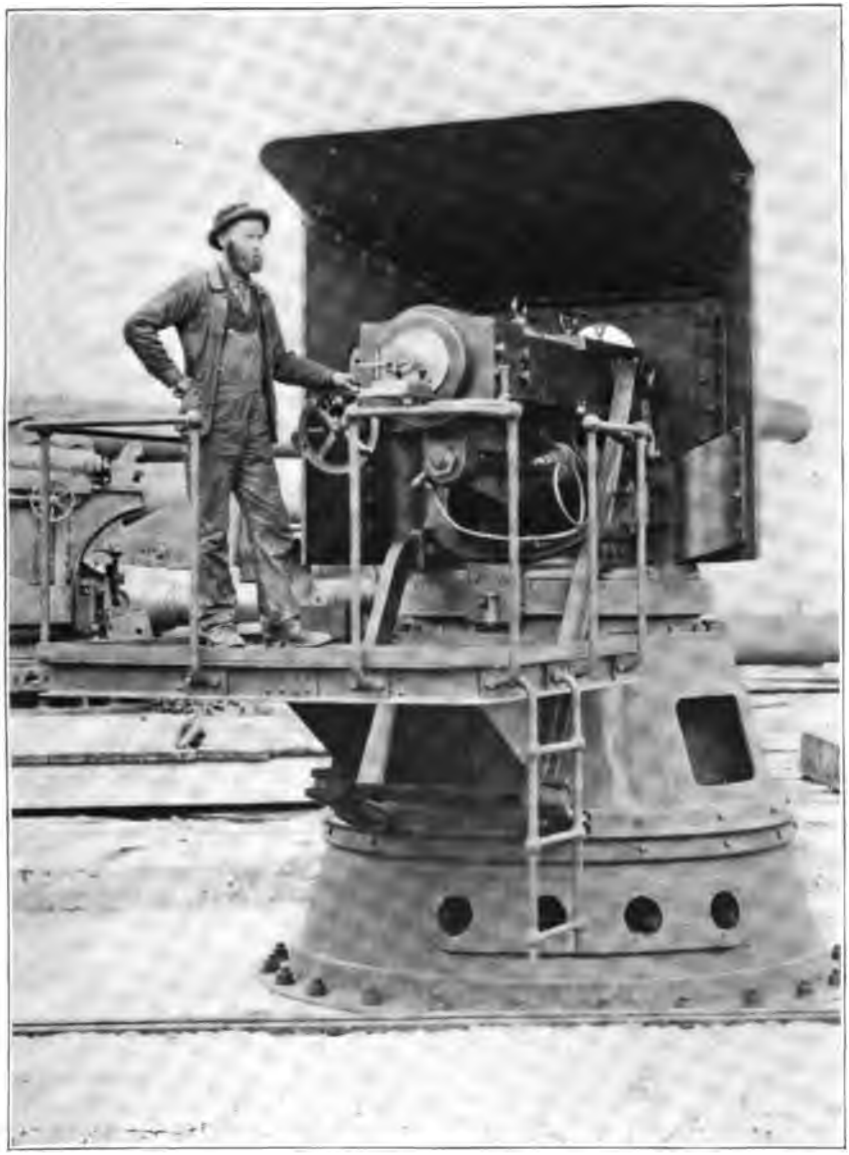


Appendix 3, p. 98.

BREECH MECHANISM OPENED. CANÉT 4.7-INCH R. F. GUN.

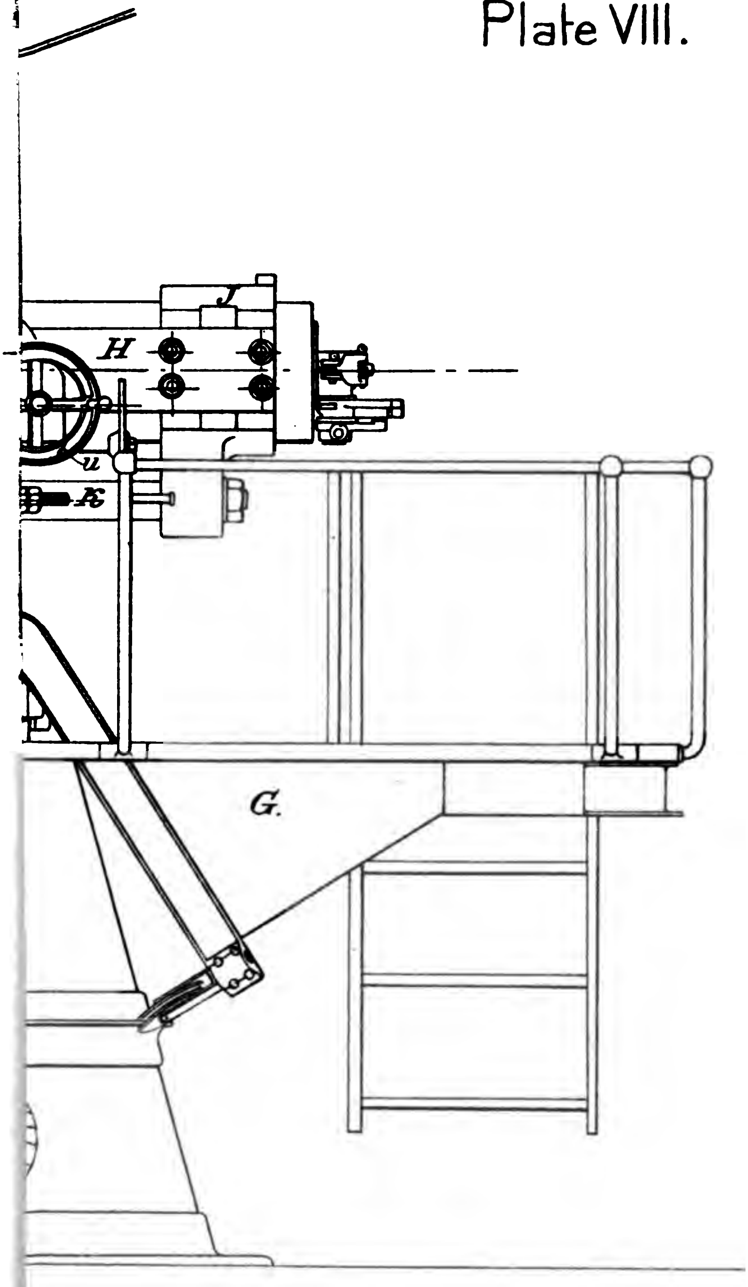


CANÉT 4.7-INCH R. F. GUN AND MOUNT.



CANÉT 4.7-INCH R. F. GUN AND MOUNT.

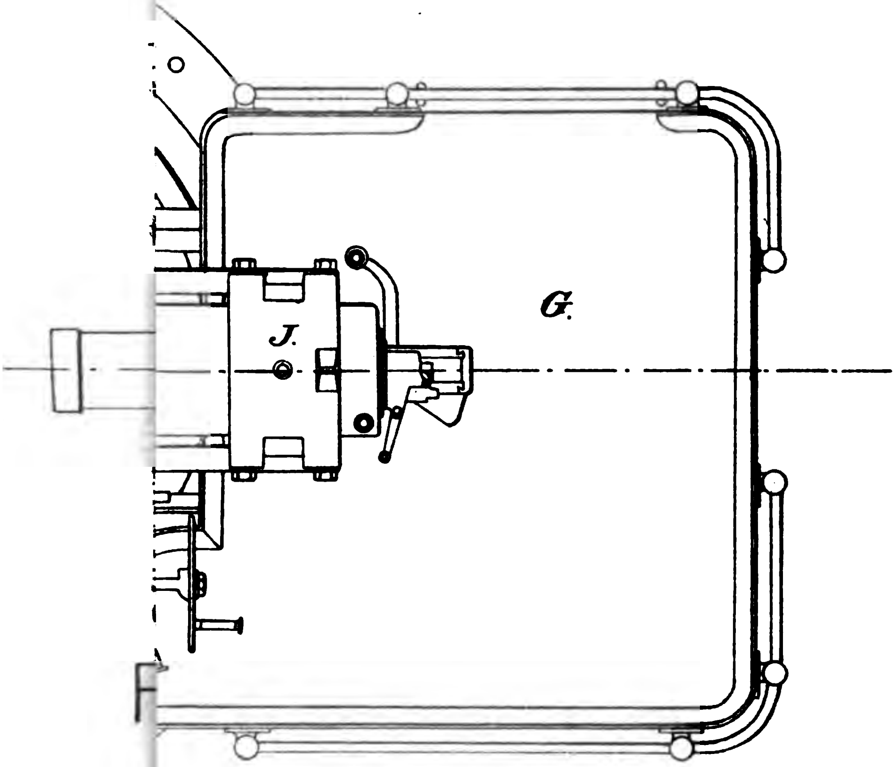
Plate VIII.



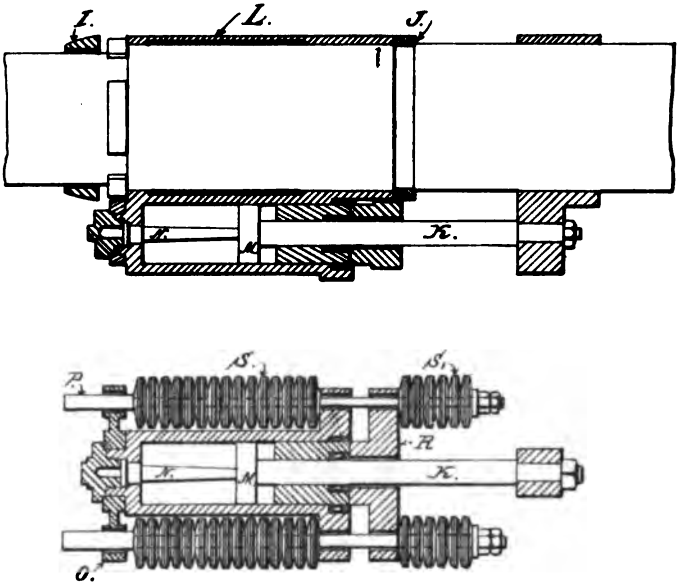
96.

Ord 54 2

Plate IX.



pendix 23, 1896.

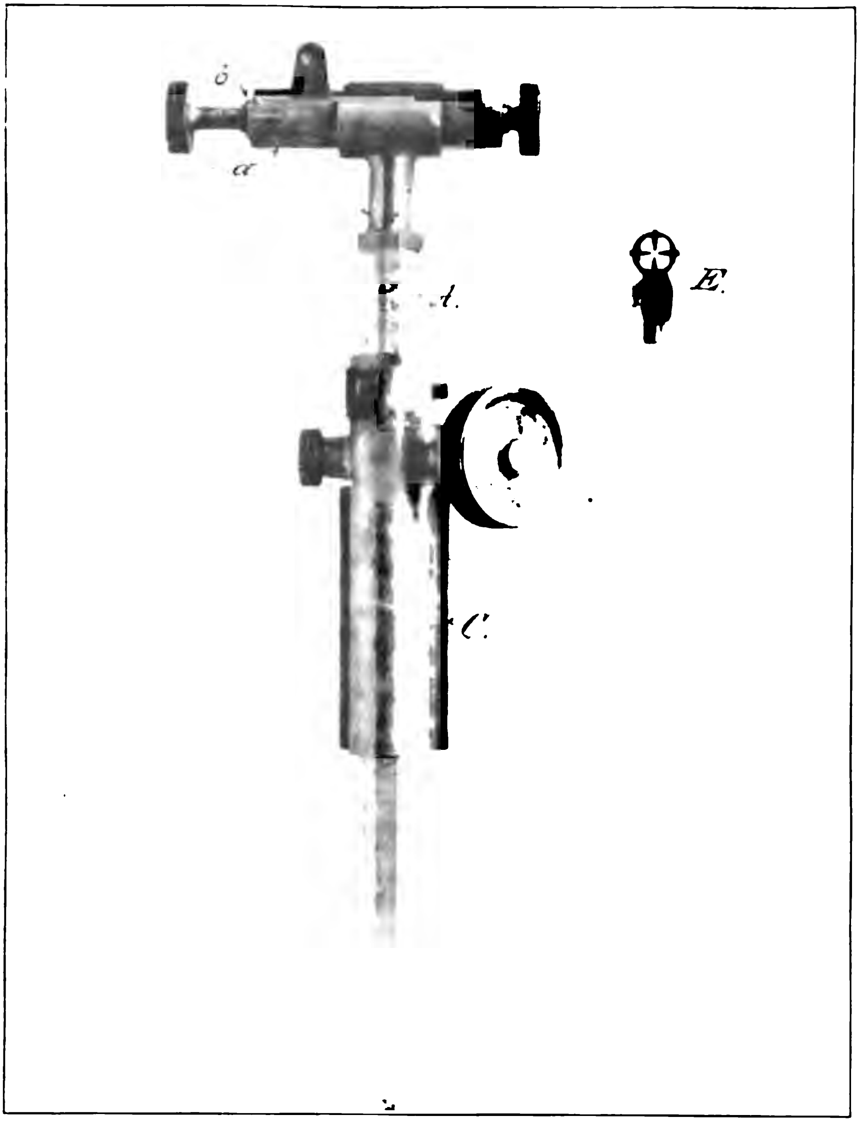


Recoil-Mechanism.

Canet 4.7 Inch R.F. Gun-Mount.

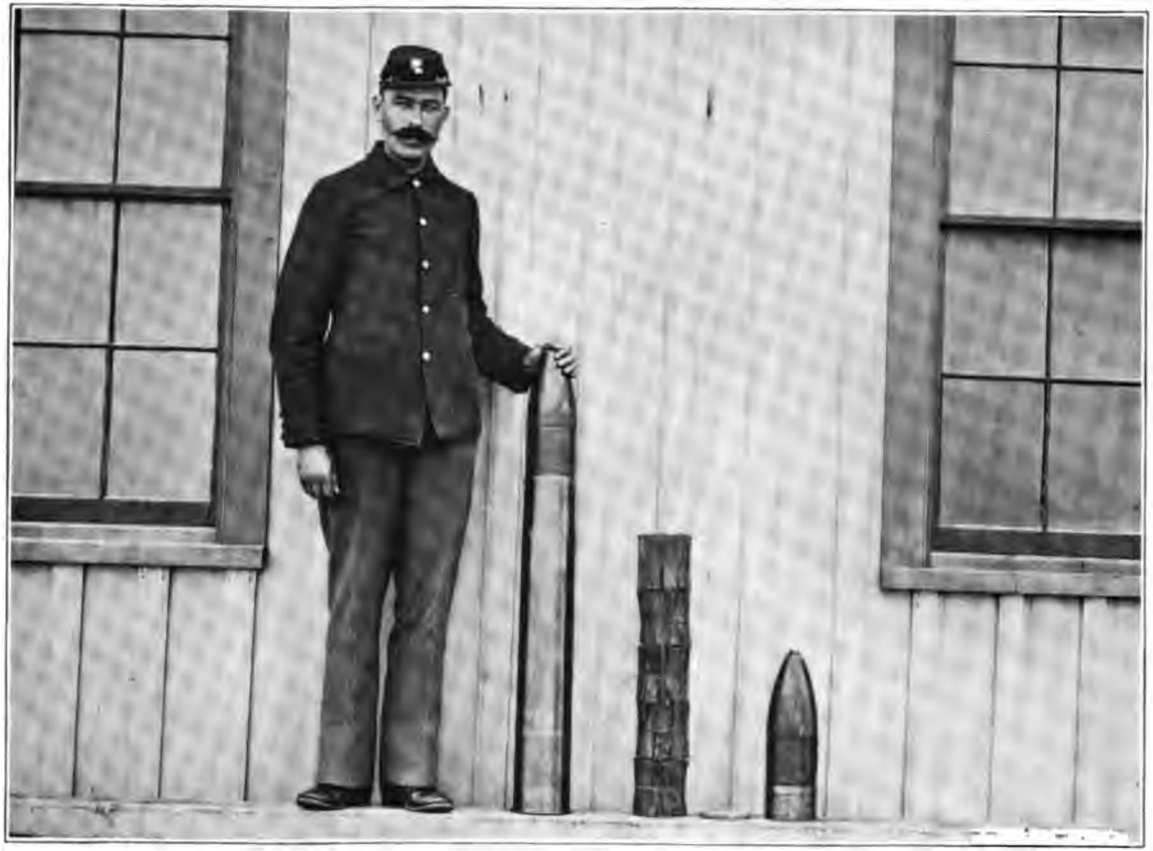
Ord 54 2

PLATE XI.

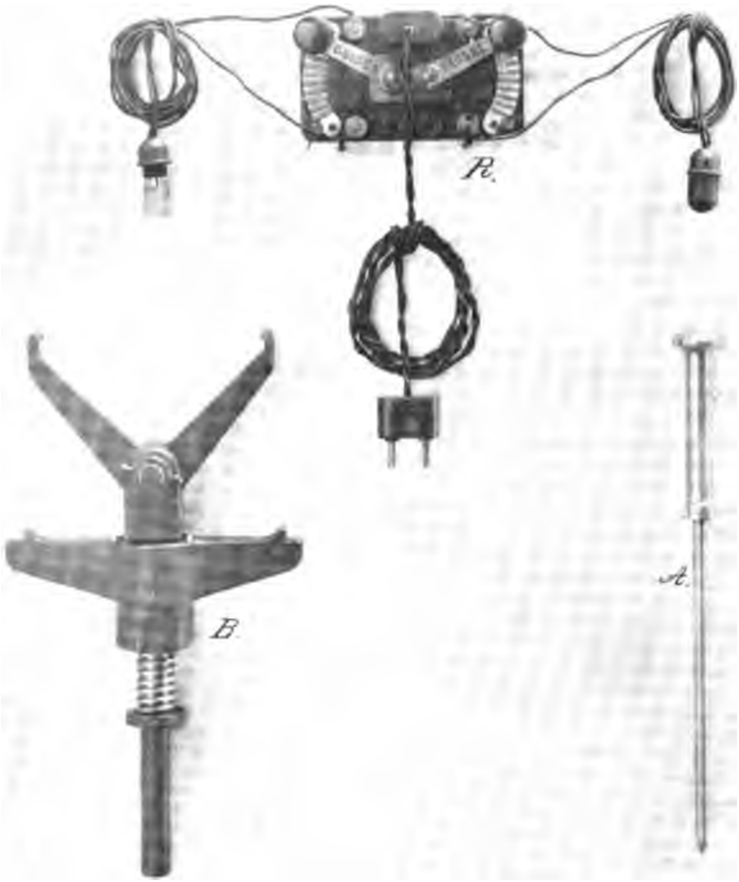


Appendix 23, 1896.

SIGHTS. CANÉT 4.7-INCH R. F. GUN.



AMMUNITION. CANÉT 4.7-INCH R. F. GUN.

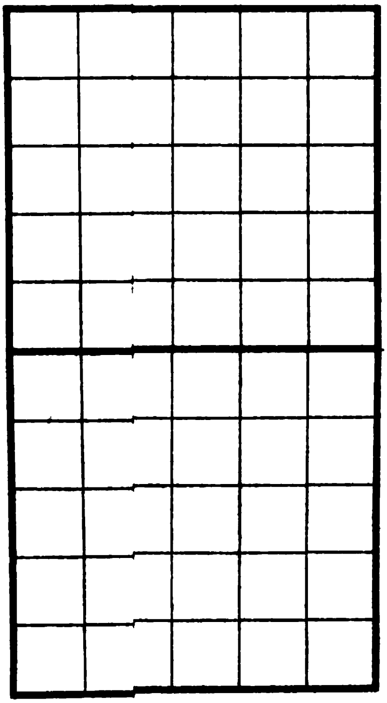


ACCESSORIES. CANÉT 4.7-INCH R. F. GUN.

Plate, XIV.

N. J. Aug 26th 1895.

Number of misses,..............................



Center 45 feet...............................

777 "...............................

Point ....

Appendix 23, 1896.

Ord 54 2

J. J. Aug 26th 1895.

8868, ...

5 feet. ....

777 " ....

....

— FOR —

— THE ORD

Montgomery

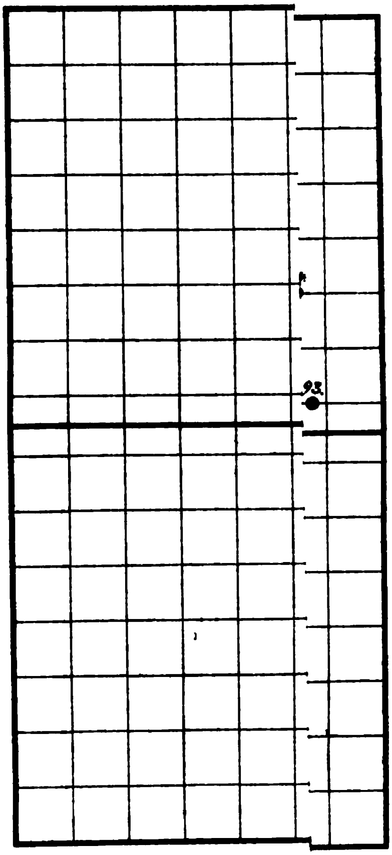
— LIEUT. ORDNANCE DEPT. U. S. A. —

Ord 54 2

Plate XV.

TARGET

Number of shots fired, 10



⊛ *Center of impact.*

⊛ *Point aimed at.*

Target 30'

dix 23, 1896.

Ord 54 2

APPENDIX 24.

TRIAL OF DRIGGS-SCHROEDER 4-INCH RAPID-FIRE GUN.

THE ORDNANCE BOARD, U. S. A.,
NEW YORK ARSENAL,
GOVERNORS ISLAND, NEW YORK HARBOR,
New York City, November 11, 1895.

SIR: The Board respectfully submits the following report of the test of a Driggs-Schroeder 4-inch rapid-fire gun, made in compliance with instructions contained in first indorsement on Ordnance Office file No. 9105, inclosure 3, dated August 26, 1895:

DESCRIPTION.

This gun is similar in all respects to the 6-pounder described in Appendix 33 to the Report of the Chief of Ordnance for 1894. For a description of the 4-inch gun reference is therefore made to the report above referred to (pp. 363 to 367). The parts, while the same in number as the 6-pounder, are of course made larger and stronger to conform to this increased caliber. The weights and dimensions of the principal parts of the gun and its ammunition are summarized in the following tables:

Caliber	inches	4
Total length	do	164
Length of bore	do	157.5
Length of bore	calibers	39.4
Travel of shell	do	33
Number of grooves		30
Depth of grooves	inch	.025
Width of grooves	do	.279
Weight of breechblock	pounds	74
Weight of gun complete	do	3,500
Weight of powder charge	do	12 to 14
Volume of chamber	inches	362.7
Ratio of gun weight to projectile		106.1
Muzzle velocity	feet per sec	2,000
Muzzle energy	foot-tons	915
Energy per ton of gun	do	586

AMMUNITION.

Steel shell:		
Total length	inches	12.10
Weight of shell	pounds	32.2
Weight of burster	do	.67
Weight of fuse	do	.133
Weight, total	do	33
Common shell:		
Total length	inches	15.1
Weight of shell	pounds	30.96
Weight of burster	do	1.9
Weight of fuse	do	.133
Weight, total	do	33
Fixed ammunition:		
Total length (steel shell)	inches	44.77
Total length (common shell)	do	47.77
Weight of empty case	ounces	192
Weight of charge	do	192 to 224

The following programme was adopted for the test:

The gun to be carefully examined by the Board. The number of parts of the breech mechanism, their strength, simplicity, and certainty of action to be noted; also the ease, safety, and certainty of the breech mechanism as a whole. Note especially the action of the firing pin and extractor, and the maximum outward position of the cartridge when it can be pushed home by the breechblock. During this examination as many rounds as necessary to be fired at will.

RAPIDITY.

Determine the time required to fire 25 rounds, noting carefully during the firing, and especially at the termination of the test, the condition of the gun as regards ease and certainty of action.

DUST.

The mechanism of the gun to be exposed to a blast of fine dust in such a manner as to insure its being well covered with the dust, after which five rounds to be fired.

EXCESSIVE PRESSURES.

The gun to be fired five rounds with gradually increasing pressures, the maximum being about 33⅓ per cent above the service pressure.

DEFECTIVE CARTRIDGES.

The gun to be tested with defective cartridges in the same manner as heretofore in the trial of rapid-fire guns.

RUST.

Three rounds to be fired after the mechanism has been thoroughly rusted.

The gun to be then subjected to such further firings as may be considered advisable by the Board.

PRELIMINARY FIRING.

The action of the mechanism in deliberate firing was very satisfactory. All parts of the mechanism are securely housed and protected from exposure to the weather. The breechblock is light for the caliber and its manipulation easy and certain. The lightness of the breechblock and its housing permits the use of a long gun without great total weight and the realization of high velocity due to the resulting increased travel of the shot in the bore. This block under normal conditions has no tendency to fly open. If a cartridge case becomes stuck in the chamber, the mechanism can be easily dismounted and the case driven out from the front. The cartridge can be pushed home by the block in closing when it is at a distance of 3½ inches from the seat. This operation is attended by no danger whatever of a premature explosion due to a protruding firing pin, as the movement of the block is such that the protruding pin can not be brought into contact with the primer until the block is closed and locked. Moreover, the chances of a protruding firing pin are reduced to a minimum in this system, as the pin is always retracted to within the limits of the block before the latter can descend, and is therefore protected from danger of becoming broken or bent and wedged in its seat. The gun can not be fired until the breech is closed and locked, as up to the completion of this motion the arm of the cocking cam is interposed sufficiently to prevent this firing pin from striking the cap. The position of the man who aims and fires the gun, as well as of the one who manipulates the block, is on the side of the gun well forward of the breech. No portion of the body of the man working the block is at any time during the firing required to be in rear of the gun. This is considered by the Board a very important and valuable feature, as under other conditions it might easily happen in the excitement of rapid firing that the piece would be fired at the instant the block was closed and before the man at the block could get out of the way. The effect of the recoil under these circumstances would be serious, if not fatal.

During the preliminary firings the charge corresponding to the standard pressures for the gun was determined to be 9 pounds of Q. B. E. sphero-hexagonal powder, and 10 pounds of a blend of W.-A. and W. F. brown prismatic powder was fixed as a safe charge for the rapidity test.

RAPIDITY.

The ammunition for this test consisted of 21 new and 4 old cases, 3 of which had already been fired three times and 1 twice. The four fired cases gave considerable trouble, due to their imperfect condition. After making deduction for delays caused by the sticking of these cases, the total time for the 25 rounds was 2 minutes and 34 seconds. The first 21 rounds were fired smoothly and without delays from the sticking of cases in exactly 2 minutes, and although the firing was conducted under adverse circumstances, due to the direction of the wind, which blew the smoke into the faces of the gunners, this time may be considered as fairly representing the rapidity of the gun.

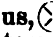
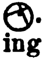
DUST TEST.

The parts of the mechanism having been cleaned and lightly oiled, were subjected to a blast of pulverized sand for 8 minutes. The breechblock was then opened without difficulty, sand and dust were removed from the mechanism by hand and from the chamber by a sponge; the gun was then loaded and fired. The total time required was 1 minute and 15 seconds.

EXCESSIVE PRESSURES.

The gun was fired five rounds with increasing pressures up to 47,000 pounds per square inch. The mechanism worked well throughout the test.

DEFECTIVE CARTRIDGES.

The first case was rendered defective by cutting four radial slots through the rim at the extremities of two diameters thus, , and the second by two slots cut through the head, the slots intersecting at a point midway between the center and circumference of the head thus, . Upon firing the first case the gas escaped into the mechanism, drying up the oil and covering the mechanism with residue. The block worked stiffly on account of lack of lubrication; in other respects the gun received no injury. Upon firing the second case the block was found partially opened, the operating handle having made about a quarter turn. The block could not be opened by hand, and could only be turned by blows of a sledge hammer. The locking spring, right extractor, and sear were broken. The firing pin could be cocked, but owing to the displacement of the cam so that the shoulder ceased to bear against the firing pin, the latter could be fired in any position. The outer portion of the main bolt was broken within half an inch of the exterior surface of the jacket. As the remainder of the bolt could not be removed by the hammer, it was drilled out, and was then found to be in three pieces. The three parts had been considerably bent downward. The broken parts having been replaced, the gun was fired three rounds to test the working of the mechanism, and was then subjected to the test by blowbacks. These were produced by thinning the metal in rear of the primers sufficiently to insure that the primer would be broken at discharge so as to allow the powder gases to pass through the primer hole of the cartridge case into the mechanism. Three rounds were fired. The mechanism received no injury except that due to fouling, and the block worked easily after each round.

RUST TEST.

For this test the gun was dismounted from its carriage and slung vertically from a gin. The parts of the mechanism were washed in a solution of soda lye and all traces of oil removed; the parts were then assembled after being perfectly dried. The breech of the gun was immersed in a 15 per cent solution of salammoniac for 25 minutes, after which the gun was allowed to remain in a horizontal position for 48 hours, and was then replaced in its mount. The breechblock was then opened in 20 seconds, the guide bolts and firing pin were oiled, the wooden plug which closed the chamber removed by a rammer from the front, a primed empty case inserted, and breechblock closed. The total time to open the block, perform the above operations, and fire the primer was 41 seconds. Three service rounds were then fired without difficulty. The mechanism having been dismounted, all the parts were found well rusted.

WOODEN MAIN BOLT.

As some doubt existed as to whether, under normal conditions, any portion of the pressure on the block could be transmitted to the main bolt, the latter was replaced by a wooden bolt of the same dimensions. The bearing surfaces on the block and jacket were well cleaned and dried, in order to utilize as much friction as possible. Two rounds were then fired with half and full charges, respectively; the bearing surfaces were then thorougly lubricated to diminish friction, and the two rounds were repeated. The wooden bolt was uninjured.

CONCLUSIONS.

As a result of this test the Board is of the opinion that the Driggs-Schroeder 4-inch has shown itself to be a simple, safe, and efficient mechanism for a rapid-fire gun of this caliber. When the Department has decided upon the proper caliber for this class of guns, it is recommended that a gun of the adopted caliber be purchased by the Government in order that the strength of this system may be subjected to a more exhaustive test than was possible with the 4-inch gun, which is the subject of this report, in view of the circumstances under which it came into the temporary possession of the Government.

FRANK H. PHIPPS,
Major, Ordnance Department, U. S. A., President.
FRANK HEATH,
Captain, Ordnance Department, U. S. A.
WILLIAM CROZIER,
Captain, Ordnance Department, U. S. A.

The CHIEF OF ORDNANCE, UNITED STATES ARMY,
Washington, D. C.

(9105—Enc. 8)

Record of firing with Driggs-Schroeder 4-inch rapid-fire gun No. 1 (weight 3,613 pounds;

[Object of firing, to

Date.	No. of fire.	Powder.				Projectile.		Elevation.	Pressure per square inch of bore.	Recoil.	
		Kind.	Weight.		Number of prisms.	Kind.	Weight.				
1895.			*Lbs.*	*Oz.*			*Pounds.*	° ′	*Pounds.*	*Ft.*	*In.*
Sept. 20	1	Sphero-hexagonal, I. B. E.	8	0	....	Shell, lot 692.	33	....	20, 25,969	7	9
Sept. 20	2		11	0	....		33	....	15, 47,400	8	0
Sept. 20	3		9	0	....		33	....	20, 34,222	8	0
Sept. 20	4		9	0	....		33	....	15, 34,333	8	0
Sept. 20	5		9	0	....		33	....	20, 35,760	8	0
Sept. 20	6		9	0	....		33	....	15, 35,820	8	0
Sept. 20	7	Brown prismatic. W. U .... W. F., lot 2 ..	8 1 10	15 1 0	96 27		33	....	20, less than 24,000	7	0
Sept. 20	8	W. F., lot 2 ..	10	0	260		33	....	15, 25,150	7	0
Sept. 20	9	W. F., lot 2 ..	10	4	270		33	....	20, 29,477	7	0
Sept. 21	10	W. U .... W. F., lot 2 ..	8 1 10	15 1 0	96 27		33	....	15, 23,036	8	0
Sept. 21	11	W. U .... W. F., lot 2 ..	8 1 10	15 1 0	96 27		33	....	20, 23,533	9	0

[Object of firing, to

Date.	No. of fire.	Powder Kind.	Lbs.	Oz.	Number of prisms.	Projectile Kind.	Weight.	Elevation.	Pressure per square inch of bore.	Recoil.
1895. Sept. 25	12 to 36	Brown prismatic. W. U. W. F., lot 2.	8 1 10	15 1 0	....	Shell, lot 692.	33	....	....	....

[Object of firing,

Date.	No. of fire.	Powder Kind.	Lbs.	Oz.	Number of prisms.	Projectile Kind.	Weight.	Elevation.	Pressure per square inch of bore.	Recoil.
1895. A. M. Sept. 26	37 to 41	Sphero-hexagonal, I. B. E.	9	0	....	Shell, lot 692.	33	....	....	....

mark II), at Sandy Hook Proving Ground, from September 20 to October 22, 1895.

determine the charge.]

Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Wind from front, 10 miles an hour; barometer, 30.19; thermometer, 88°; humidity, 66.	Cylinder leaking slightly	Gun mounted on 4-inch Navy mount. The breech mechanism consists of 12 pieces. The block will force the case home when the latter is within 3¼ inches of its seat in the chamber. An igniter of 2 ounces rifle powder was used with the charge of brown powder. Present: Maj. F. H. Phipps, Ordnance Department; Capt. F. Heath, Ordnance Department; Capt. W. Crozier, Ordnance Department.
	Second time for firing this case	
	Second time for firing this case. Holding-down bolts of carriage tightened.	
	There were 2 sizes of prisms in the powder charge: the larger were put in the center of the cartridge, the smaller along the side. Second time for firing this case.	
	Third time for firing this case	
	Powder thrown in case loose. Second time for firing this case.	
	Third time for firing this case	
	Third time for firing this case	

test gun for rapidity.]

	GENERAL REMARKS.
....	The detachment consisted of 1 officer and 5 men. Lieutenant Montgomery operated the block and fired the gun throughout the firing. The ammunition consisted of 21 new and 4 old cases, 3 of which had already been fired 8 times and 1 twice. The 21 new cases were fired in 2 minutes, the remaining 4 old cases in 34 seconds. The number of rounds fired during the first minute was 10; during the second minute, 11. An old loaded case stuck after the twenty-first round, causing a delay of 1 minute and 4 seconds, and another loaded case stuck after twenty-second round, causing a delay of 10 seconds. Total time required for firing the 25 rounds, including delays, 3 minutes 48 seconds. Deducting the delays makes 2 minutes 34 seconds for firing the 25 rounds. The old cases stuck quite fast in the chamber, requiring the use of both hands to force them home and to extract them. The wind was from direct front, and the smoke was so dense that it was almost impossible to see the gunner 2 feet away. Present: Capt. F. Heath, Ordnance Department.

dust test.]

....	On Sept. 25 the parts of the breech mechanism were cleaned and lightly oiled. The breech mechanism was then subjected to a blast of pulverized sand for about 1 minute. The experiment was postponed on account of difficulty of obtaining a proper strength of blast. On Sept. 26 the apparatus was overhauled, but the breech mechanism was not touched. The latter was then subjected to a blast for 8 minutes. During this experiment the trigger was not cocked, but had a drill washer on it. The breechblock opened easily, and it was attempted to fire a round without any preparation. It was found impossible to force a loaded case into the chamber on account of the dust therein The dust was removed by sponging. The round was then inserted and fired in 1 minute and 15 seconds. Total time required to fire 5 rounds was 3 minutes and 20 seconds. No oil, water, or rag was used in preparing the mechanism for the above firing. The dust was only removed in places where it had accumulated in large quantities, and then the removal was by hand. The breech mechanism, after the firing, was dismounted and cleaned for the excessive-pressure test. Present: Capt. F. Heath, Ordnance Department; Capt. W. Crozier, Ordnance Department.

Record of firing with Driggs-Schroeder 4-inch rapid-fire gun No. 1 (weight

[Object of firing,

Date.	No. of fire.	Powder.			Projectile.		Elevation.	Pressure per square inch of bore.	Recoil.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.			
1895.			*Lbs. Oz.*			*Pounds.*	° ′	*Pounds.*	*Ft. In.*
Sept. 26	42	Sphero-hexagonal, I. B. E.	9 6	....	Shell, lot 692.	33	....	10, 41,980	0 8
Sept. 26	43		9 12	....		33	....	25, 42,467	0 8
Sept. 26	44		10 2	....		33	....	10, 43,622	0 9
Sept. 26	45		10 8	....		33	....	25, 47,244	0 9
Sept. 26	46		10 8	....		33	....	10, 45,960	0 9

[Object of firing,

1895. Sept. 26	47 48	Sphero-hexagonal, I. B. E.	9 0	....	Shell, lot 692.	33	....	....	....

[Object of firing, to test the

1895.									
Oct. 10	49	Sphero-hexagonal, I. B. E.	9 0	....	Shell, lot 692.	33	....	10, 33,420	8 0
Oct. 10	50		9 0	....		33	....	20, 32,200	8 0
Oct. 10	51		9 0	....		33	....	10, 35,740	8 0

[Object of firing,

1895.									
Oct. 10	52	Sphero-hexagonal, I. B. E.	9 0	....	Shell, lot 692.	33	....	....	....
Oct. 10	53		9 0	....		33	....	....	....
Oct. 10	54		9 0	....		33	....	....	....

[Object of firing, to test

1895.									
Oct. 10	55	Sphero-hexagonal, I. B. E.	9 0	....	Shell, lot 692.	33	....	10, 33,655	8 0
Oct. 10	56		9 0	....		33	....	20, 33,909	8 0
Oct. 10	57		9 0	....		33	....	33,945	8 0

3,613 pounds; mark II), at Sandy Hook Proving Ground, etc.—Continued.

excessive charges.]

Wind, strength and direction.	General remarks.
....	32,000 coppers of 1895.
....	32,000 coppers of 1895.
....	40,000 coppers of 1893.
....	40,000 coppers of 1893. Case stuck and a rammer used to remove it.
....	40,000 coppers of 1893. Same difficulty with case as in previous round.
	Present: Capt. F. Heath, Ordnance Department.

defective-cartridge test.]

....	The first case was rendered defective by cutting 4 radial slots through the rim at the extremities of 2 diameters at right angles with each other as in figure . The second case was rendered defective by cutting 2 slots through head of cartridge as in figure . Upon firing the first case loaded the gas escaped into breech mechanism, completely drying up the oil and covering the mechanism with residue. The block worked stiffly after this fire, due to the absence of the oil. Upon firing the second case the block opened, the operating handle turning about a quarter turn. After this fire it was impossible to work the block by hand and it could only be turned by sledge-hammer blows. Examination showed that the locking spring was broken, the locking stud in front cutting its way through the metal about the handle, the right extractor broken about its arbor, and the sear broken. The firing pin was capable of being cocked, but it could be fired in any position. This was due to displacing of the cam, so that its shoulder ceased to bear against the firing pin. The cartridge case remained in the gun. The primer was blown out Subsequent to the above examination the main axle bolt was found broken within ½ an inch of the exterior surface of the jacket. Hammering having failed to move the main axle bolt, it was decided to remove it by drilling. After drilling, it was found that the remaining portion of the main axle bolt was broken in 2 places and its parts considerably bent downward.

working of breech mechanism.]

....	The locking spring broke while being inserted. The following new parts were supplied: A main axle bolt, 2 extractors, locking spring, and sear spring. Parts of the interior of the breechblock and the surface of the cam, which were burred, were filed.

blowback test.]

....	The breech mechanism was oiled before firing. The firing pin worked stiffly, due to fouling. The firing pin was snapped twice to get rid of fouling.
....	The block was opened in 2½ seconds after firing.
....	The block was opened 1 second after firing. The firing pin was snapped twice to get rid of fouling. The test injured none of the parts of the breech mechanism.
	The blowbacks were caused by thinning the metal in rear of the primer. After the first round the block opened without difficulty.

working of breech mechanism.]

....	Present: Capt. F. Heath, Ordnance Department.

Record of firing with Driggs-Schroeder 4-inch rapid-fire gun No. 1 (weight

[Object of fir-

Date.	No. of fire.	Powder.			Projectile.		Elevation.	Pressure per square inch of bore.	Recoil.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.			
1895.			*Lbs.* *Oz.*			*Pounds.*	° ′	*Pounds.*	*Ft.* *In.*
Oct. 21	58	Sphero-hexagonal, I. B. E.	9 0	....	Shell, lot 692.	33	5 56	10, 32, 960	0 8
Oct. 21	59		9 0	....		33	5 56	20, 83, 220	0 8
Oct. 21	60		9 0	....		33	5 56	10, 34, 222	0 8

[Object of firing, to determine the strain

1895.									
Oct. 22	61	Sphero-hexagonal, I. B. E.	4 8	....	Shell, lot 692.	33	....	10, 10, 475	0 6
Oct. 22	62		9 0	....		33	....	20, 83, 300	0 8
Oct. 22	63		4 8	....		33	....	10, 10, 050	0 6
Oct. 22	64		9 0	....		33	....	20, 83, 782	0 8

3,613 pounds; mark II), at Sandy Hook Proving Ground, etc.—Continued.

ing, rust test.]

Wind, strength and direction.	General remarks.
....	In order to carry out this experiment it was necessary to dismount the gun and sling it vertically from a gin. The breech mechanism was placed first in a hot solution of soda lye and afterwards thoroughly washed with soap and hot water to remove all traces of oil. The mechanism was mounted in a perfectly dry condition. A wooden plug covered with a well-oiled serge material was inserted in the chamber to prevent its rusting. The breech of the gun was immersed in a 15 per cent solution of sal ammoniac at 1.15 p. m. and taken out at 1.40 p. m. It was then unslung, laid in a horizontal position, and completely covered with a tarpaulin. On the morning of the 21st the gun was mounted; at 3 p. m. the same day the breechblock was opened; the operation required 20 seconds; the guide bolts and the firing pin were oiled, the wooden plug removed, and a primed empty case was inserted and breechblock closed. The total time required to open the block, perform the above operations, and fire the primer was 41 seconds. 3 service rounds were now fired, with the results as tabulated. Block opened easily each round. After firing, the breech mechanism was dismounted for examination, when it was found that the block exterior and interior, the bands and grooves in the gun, the main axle bolt, the firing pin, the firing-pin spring, the sear, the sear spring, and the extractors were well rusted. All the parts of the mechanism were then remounted and cleaned. While preparing for the above firing the locking spring broke, from no cause outside of its own weakness. The locking springs all seem to be too weak for their purpose, the last one that broke being the third furnished the gun. The object of the locking spring is to prevent the rotation of the main axle bolt from any force applied to the block or cam, and to retain the operating lever on the main axle bolt. If the force is applied to the block, the locking spring can only act after the block has fallen, and then it functions too late. Owing to the inaccessibility of the cam, it is not conceivable that any force can be brought to bear on it to rotate the main axle bolt. The locking spring prevents sliding of the operating lever on the main axle bolt, a function which eliminates such inconvenience as may arise from the sliding of the lever during the working of the breech mechanism. It was noticed during the firing that the primer was not struck fairly in its center. This was due to filing away the bearing surfaces of the cam and block, so that the latter did not enter fully into its housing in the jacket. Present: Capt. F. Heath, Ordnance Department; Capt. W. Crosier, Ordnance Department.

on main axle bolt during firing.]

....	The object of this test was to determine whether any strain was brought to bear on the main bolt during firing. The breech mechanism was lubricated with the exception of the bearing surfaces in the jacket, which were dried thoroughly. The loaded case (one-half charge) was first inserted and block locked. As a precaution 2 wooden washers were placed on the firing pin to prevent contact with the primer. The wooden axial bolt of white pine was substituted for the steel one, and the gun fired. The block did not open, nor was there any indication of strain on the wooden bolt. The wooden bolt was then removed, and the block opened with the steel one. With the second round, full charge, the same methods were followed and the same results obtained. It was now decided to lubricate with lard oil the whole surface of the block and the housing in the gun and to repeat the experiment. To test the effect of closing the block on a protruding primer, 1 was obtained which protruded $\frac{1}{16}$ inch. The effect of closing the block was to seat the primer properly. The test with lubricated surfaces and one-half charge gave the results as with dry surfaces. The test with full charge gave the same result, except, while the wooden bolt was not bent, it was slightly split in 2 places. This result was probably due to fall of the block, due to the cam not bearing against it, and caused by the vibration set up by the shock of discharge. The cam failed to force the block fully into its bearing, which was remedied by applying a lever directly under the block. After the last round it was noticed that the block fell to its bearing on the block. Present: Capt. F. Heath, Ordnance Department; Capt. W. Crosier, Ordnance Department. George Montgomery, Lieutenant, Ordnance Department, U. S. A. For the Board: Frank H. Phipps, Major, Ordnance Department, U. S. A., president.

APPENDIX 25.

TRIAL OF HOTCHKISS 12-CM. (4.72-INCH) RAPID-FIRE GUN AND MOUNT.

(2 plates.)

THE ORDNANCE BOARD, U. S. A.,
NEW YORK ARSENAL,
GOVERNORS ISLAND, NEW YORK HARBOR,
New York City, May 25, 1896.

SIR: The following report of the test of a Hotchkiss 4.72-inch rapid-fire gun and mount is respectfully submitted.

DESCRIPTION.

THE GUN.

The gun consists of a tube, jacket, a hoop in the prolongation of the jacket, a locking ring by which the jacket and hoop are secured to the tube, and a ring having a screw thread on its outer surface by which the gun is secured to the cradle. The breech mechanism is in its general features the same as that of the 6-pounder described in the report of the Chief of Ordnance for 1894. It is of the old standard model and differs from the 6-pounder which is of model 1893 in the following particulars: The firing point is made with rear projecting spring ears, which clasp the end of the hammer. The mainspring is a double-branched flat spring whose ends are caught on opposite sides of the hammer axes. The sear spring is flat. The extractor has its nib and body in a single piece. The stop bolt screws into its seat. The trigger is of ordinary bent-lever form. The cocking toes are arranged to cock by downward pressure. It is provided with a pistol grip. The crank handle is permanently attached to the crank shaft.

The principal weights, dimensions, etc., of the gun and its mount are as follows:

Total length	inches	182
Length of bore	calibers	36.5
Weight of gun	pounds	4,370
Weight of mount	do	5,610
Weight of shield	do	1,760
Weight of projectile	do	55 36
Weight of charge (brown powder)	do	17
Initial velocity	feet per second	1,790 2,280

THE MOUNT.

(Plates I and II.)

The mount consists, essentially, of a cradle, chassis, shield, pedestal, and traversing and elevating mechanisms.

The cradle comprises a recoil part and a nonrecoil part.

The recoil part consists of the threaded sleeve A, the pistons and their rods, and the spring compressors B. The gun has no trunnions and is attached to its cradle by having a portion of its jacket cut with a left-hand thread, this threaded portion engaging with a corresponding one cut on the interior of the threaded sleeve. When the gun is screwed home, a key inserted in the threaded parts prevents rotation of the gun.

The threaded sleeve is enlarged on each side of the axis of the gun, forming projections to which in front are attached the piston rods and in rear the spring compressors. These projections are cut away underneath, forming surfaces which partially embrace the recoil slides, and, moving on them during recoil, control the direction of motion of the gun. The spring compressors B compress the springs contained in the cylinders D, storing up the power required to return the gun to the firing position.

The nonrecoil part, with the exception of the hydraulic cylinders, is a single casting. It comprises the hydraulic cylinders C, the spring cylinders D, the sleeve E, the trunnions, and recoil slides. The hydraulic cylinders constitute the forward part of the cradle, and are symmetrically disposed on each side of the axis of the gun. The strain on the piston rods during recoil is a tension. To the left cylinder is bolted the front sight.

The spring cylinders D are underneath the sleeve E on each side of the gun. The sleeve E embraces the gun, holding it in place during recoil and permitting it at the same time to move through it. The recoil slides are located one on each side of the gun, underneath, and in prolongation of the projections on the threaded sleeve. On these slides moves the threaded sleeve. The extent of recoil is about 8.75 inches. A rack is bolted to the left side of the cradle in which engages a pinion for giving the cradle a motion in elevation. The lanyard is pulled through a small tube located on the left side of the cradle. The direction of the pull is changed by a lever, in order that the trigger may be pulled to the front, while the toggle is pulled to the rear. On the left side of the cradle is the socket F for the breech sight.

The chassis is a single casting comprising the two cheeks and the bottom transom. The chassis supports the shield and the trunnions of the cradle. The two are prolonged to the front, forming brackets to which is bolted the front face of the shield and on which rest the side faces. The left cheek is adapted to the mountings for the traversing and elevating mechanisms, and to it is bolted the shoulder piece G. The lower part of the bottom transom forms the racer. Two clips in front and one L in rear prevent tilting of the chassis.

The shield comprises a 2.75-inch front plate, an inch crown plate, and two 1.25-inch side plates, all bolted together with angle irons. The front plate has openings in it for the gun and for sighting. The front plate is bolted to the cheeks of the chassis, and the side plates rest on them.

The pedestal P is of a generally conical shape, flanged at the bottom, where it is secured by bolts to the foundation. Its upper surface forms the base ring, and to it is fastened the circular rack for traversing.

For traversing, the chassis rests on conical rollers, which in turn rest on the base ring or upper surface of the pedestal. Turning the handwheel H operates at the end of its axis a worm, which engages with a worm wheel on a vertical axis. This vertical axis is located between the cheeks of the chassis and passes through the bottom transom. The lower end of this axis has on it a pinion, which engages with the circular rack on the pedestal.

The axis of the handwheel can be readily shifted, disengaging the worm and worm wheel. Traversing can now be given by means of the shoulder piece.

Elevation is given by the handwheel J. The shaft of the handwheel has on it a worm, which operates the worm wheel K. The axis of the latter has on its other extremity a pinion, which engages with the rack on the cradle.

SIGHTS.

The breech sight consists of a bar for elevation and a crosshead for deflection. The bar is an octagonal-shaped bar, having its front face graduated in degrees, with subdivisions to one-fifteenth of a degree. The right front face has on it a scale of equal parts reading to millimeters. The bar is given a vertical motion by a worm engaging in a rack formed on one of the faces of the bar. The crosshead is slotted throughout its length, forming a receptacle for a screw, which is operated by two thumbscrews, one at each end of the crosshead. On this screw the open sight forms a nut, and lateral motion is given it by means of either thumbscrew. The deflection scale is formed on the crosshead, and it reads to millimeters. The breech sight is seated in a socket, F, formed on the left side of the cradle. The front sight is a blunt point, forming a part of a bracket bolted to the left hydraulic cylinder.

The programme adopted for the test of 4.72-inch rapid-fire guns is as follows:

Each gun to be carefully examined by the board. The number of parts of the breech mechanism in each, their strength, simplicity, and certainty of action, to be noted; also the ease, safety, and certainty of the breech mechanism as a whole. Note especially the action of the firing pin and extractor, and the maximum outward position of the cartridge when it can be pushed home by the breechblock. During this examination 20 rounds to be fired at will from each gun.

VELOCITY.

Five rounds to be fired for velocity from each gun with full charges.

ACCURACY.

Ten rounds to be fired at each range of 1 mile and 3,000 yards, the same conditions of aiming being repeated at each round with the guns, respectively, and the mean deviations determined.

RAPIDITY.

Determine the number of rounds that can be fired in 3 minutes, noting carefully during the firing, and especially at the termination of the test, the conditions of the gun as regards heat and ease and certainty of action.

Two detachments of men to be used, the first to be relieved in 1 minute and 30 seconds.

The above test to be repeated if found necessary by the board.

RAPIDITY WITH ACCURACY.

Fire 10 aimed shots as rapidly as possible at the 1,000-yard and 1-mile targets. Also 10 aimed shots at targets in same line and ranges of 500 yards and 1,000 yards alternately; also 10 aimed shots alternately at targets at about 500 yards range, placed about 75 feet apart.

TEST OF SHRAPNEL.

Against steel plates.—Two shrapnel of each kind to be fitted with Frankford Arsenal sensitive-point fuses and fired to burst while passing through a screen placed in front of a 1¼-inch rolled-steel plate located about 150 feet from the gun, the effect on the plate of the fragments to be noted. The charge in above test to be such as to give a muzzle velocity equal to the remaining velocity at 1 mile when full charges are used.

For dispersion.—Three shrapnel of each kind to be fitted with Frankford Arsenal sensitive-point fuses and fired to burst while passing through a screen placed about 100 feet in front of the 1,000-yard target, and the number of hits and their character as regards penetration, etc., to be observed.

CANISTER.

Two canister of each kind to be fired against a 1½-inch rolled-steel plate to be located about 300 yards from the gun, and effects on the plate to be noted. Also two canister of each kind to be fired against a screen, 26 by 20 feet, located about 100 yards from the gun, the number of hits at each round to be noted.

RAPIDITY WITH ACCURACY AGAINST A MOVING TARGET.

A boat, on which is placed a suitable target, to be towed across the line of fire at the rate of about 6 miles an hour. While within ranges of from 500 to 2,000 yards, each gun to be fired aimed shots as rapidly as possible for 3 minutes. The number of hits to be noted.

DUST.

The mechanism of each gun to be exposed to a blast of fine dust in such manner as to insure its being uniformly and equally covered with the dust, after which 20 rounds to be fired from each gun as rapidly as possible.

RUST.

Five rounds to be fired after the mechanism of each gun has been rusted in a thorough and uniform manner.

EXCESSIVE CHARGES.

Each gun to be fired five charges with gradually increasing pressures, the maximum being about 33⅓ per cent above the service pressure.

DEFECTIVE CARTRIDGES.

Each gun to be tested with defective cartridges in the same manner as is usual in the trial of small arms.

ENDURANCE.

The guns which successfully pass the above test to be fired 100 rounds for endurance, during which the general efficiency of the gun and its mount, also the regularity of action of the fuses, will be carefully observed.

If at any time during the test a gun shows a marked inferiority as compared with the others, the test of this gun will be suspended.

The test, in accordance with the above programme, was commenced November 20, 1894, on which date nine rounds were fired with charges varying from 4 pounds to 10 pounds of French smokeless (B. N.) powder which had been furnished for use with this gun. Three rounds with the latter charge and 55-pound projectile gave a mean pressure of 24,390 pounds per square inch. The action of the breech mechanism during these rounds resulted in nothing worthy of special note except that the weight of the breechblock was found to be a serious hindrance to its quick and easy manipulation in closing.

VELOCITY.

With a charge of 10 pounds of B. N. powder and projectile weighing 36 pounds 4 ounces, the velocities with two rounds were 2,017 and 2,079 feet per second, respectively. With the same charge and projectile weighing 55 pounds, three velocities were taken. The results were 1,781, 1,885, and 1,881 feet per second. During the firings considerable smoke and flame issued from the muzzle at each discharge, indicating that the powder was too slow for this gun.

RAPIDITY.

For this test the charge of 10 pounds of B. N. powder was used and projectile weighing 36 pounds 4 ounces. The number of rounds fired in 1 minute was seven. On account of the slow combustion of the powder large quantities of flame rushed out of the breech of the gun each time that the block was opened; it was therefore necessary to suspend the firings after 1 minute and 12 seconds, eight rounds having been fired in this time. Efforts were then made to obtain a powder which would answer the purpose for this test. Three kinds of powder were tried, viz, brown prismatic, W. V.; sphero-hexagonal, U. F., lot 3; and I. B. E. The first was found to be too slow, the second too quick. With the I. B. E. the mean pressure of four rounds, the charge being 15 pounds, was 36,750. This powder was selected and the charge placed at 15 pounds.

The test was resumed February 19. At the first round indications of a higher pressure were observed. The cartridge case stuck in the bore and was backed out without difficulty by means of a rammer passed in from the muzzle. The head of the case was slightly distorted, and gas escaped from one of the rivets securing it. The case was not split. A second round was then fired and the same indications, though to a less degree, were observed. There was no escape of gas past the rivets. As the indications pointed to high, though not abnormal, pressures, it was decided for safety to postpone the test for rapidity and to take additional pressures. To this end a case was unloaded, a pressure plug placed in the bottom, and the charge and projectile replaced. At this round the gun burst, killing the officer in charge of the firing, Lieut. Fremont P. Peck, Ordnance Department, who had pulled the trigger. The breechblock and breech were projected about 100 yards to the rear; the pressure plug was not recovered. The body of the cartridge case remained in the gun. The head was blown off and to the left, passing into the body of Lieutenant Peck, inflicting a wound from which he died in about 30 minutes.

In loading the cases the powder was placed in a bag, and when in place the forward end of the charge was about 4½ inches in rear of the base of the projectile. With the charge used in the last three rounds, a felt wad about three-quarters of an inch thick was placed between the powder and the projectile, leaving a vacant length of about 3¾ inches. This vacant length was filled with hay.

A careful investigation was immediately begun to ascertain, if possible, the cause of this disaster. Unfortunately the pressure plug could not be found, though diligent search was made for it. The gun was star gauged, and the results showing the changes due to the rounds from the tenth to the thirty-sixth, inclusive, are forwarded herewith. No abnormal changes were discovered by these measurements. The appearance of the freshly fractured surfaces indicated good metal. To determine definitely this point, the portion of the breechblock which was ruptured from the gun by the explosion was sent to the Watertown Arsenal for examination and test in the United States testing machine at that arsenal. Four specimens were taken from this piece, one longitudinal and one tangential from each side. The following is a general summary of the results of these tests.

Summary.

	Longitudinal, side A.	Tangential, side A.	Longitudinal, side B.	Tangential, side B.
Tensile strength (pounds per square inch of original section)	89,680	95,440	90,950	92,160
Elastic limit (pounds per square inch of original section)	45,000	44,000	44,000	45,000
Elongation per inch after rupture	.23	.1433	.1700	.2167
Elongation per inch under strain at elastic limit	.001433	.001500	.001067	.001433
Reduction in diameter at point of rupture (inch)	.144	.064	.184	.124
Reduction in area after rupture (per cent of original area)	44.6	21.4	54.6	39.2
Position of rupture (inches from neck)	1.29	.80	.95	1.49
Character of broken surface	Silky.	Granular.	Silky.	Silky.

The report of the details of these tests, together with remarks upon the probable cause of the fracture, by the commanding officer of Watertown Arsenal, are forwarded herewith, being inclosure 3 to Ordnance Office file 7565.

Subsequently Mr. J. E. Howard, C. E., the expert in charge of the testing machine at Watertown Arsenal, was sent to the Proving Ground for the purpose of making a thorough inspection of the remaining fragments of the gun. His report, being inclosure 5 to Ordnance Office file 7565, is forwarded herewith. The members of the Board personally assisted Mr. Howard in these investigations, and every possible source of information was exhausted in the efforts to ascertain the cause of the accident.

Five possible causes of the failure of this gun suggest themselves for investigation: (1) Premature discharge of the gun before the breechblock was closed; (2) defective metal in the breech of the gun; (3) excessive pressure of the powder gases; (4) defective design of the gun; (5) defective workmanship in its construction.

It can be affirmed that the failure was not due to a premature discharge. The gun was fired with deliberation and care, and members of the Board who were present can positively assert that the block was closed and locked before the gun was fired.

The appearance of the fresh-fractured surfaces, together with the tests of specimens taken from the breech as reported above, show that the metal was not defective, but that it possessed all the physical qualities required in a rapid-fire gun of this caliber.

As shown by the record, the two rounds which preceded that which burst the gun gave indications of pressures which, while not thought excessive, appeared to be higher than the standard. In order to obtain all the information possible on this point advantage was taken of the presence of a rapid-fire gun of another design but having the same caliber and volume of chamber. Rounds were fired from this gun, using powder taken from cases selected promiscuously from those which had been prepared for the Hotchkiss rapidity test. The results were as follows:

Date.	Powder.			Weight of projectile.		Pressure per square inch.
	Kind.	Weight.				
1895.		*Lbs.*	*Oz.*	*Lbs.*	*Oz.*	*Pounds.*
May 3	Du Pont's sphero-hexagonal, I. B. E., taken from Hotchkiss cases.	8	0	36	0	Less than 14,000
May 3		12	0	36	0	25,400
May 3		13	8	36	4	36,500
May 3		14	0	36	4	36,711
May 3		12	0	36	4	26,255
Aug. 13		12	8	36	8	35,017
Aug. 13		13	8	36	8	37,089
Aug. 13		13	8	36	8	38,200

It was intended to carry the charge up to the weight (15 pounds) used at the time of the accident. At the seventeenth round, owing to defects in the breechblock developed by the firings, the gun was withdrawn for repairs, and up to this date has not been returned. The results are sufficient, however, to indicate that a charge of 13½ pounds was sufficient to produce the standard pressure, and that the charge selected for the rapidity test was 1½ pounds too great. Taking the highest pressure—38,200 pounds—recorded for the 13½-pound charge, the pressure in the same gun for 15 pounds of the same powder, calculated by Sarrau's formula, is 44,740 pounds. This formula has, by frequent use, proved itself very reliable, especially for this class of powder and for charges differing by small amounts. From all the indications and data obtainable, therefore, it appears that the pressure at the time of the rupture could not have exceeded 50,000 pounds per square inch, and this pressure is not sufficient to produce the rupture of a gun properly designed and built. The area of the cross section of the chamber is about 23 square inches, and that of the fractured surface about 80 square inches; a pressure of 50,000 pounds in the bore would therefore produce a strain at the fractured surface of 18,750 pounds per square inch. To produce a strain at this surface of 44,000 pounds, the elastic limit of the material, would require a powder pressure of 117,000 pounds per square inch, and for a strain of 89,000 pounds, the tensile strength of the steel, a powder pressure of 237,000 pounds per square inch. These figures indicate that the cause of the failure was not the lack of sectional area of metal at the place of fracture. As to the possibility of defect of manufacture, an examination of the gun after the accident showed a projection of the tube at the rear of about one-tenth of an inch (Pl. III). This projection was not noticed before the accident, and it is probable that in manufacture the ends of the jacket and tube were faced off even. The constraint evidenced by this projection may have produced local strains at *a*, tending to start a fracture.

Anything more than the above conjectures in regard to the cause of the accident is entirely in the nature of speculation.

FRANK H. PHIPPS,
Major, Ordnance Department, U. S. A., President.
FRANK HEATH,
Captain, Ordnance Department, U. S. A.
J. C. AYRES,
Captain, Ordnance Department, U. S. A.
WILLIAM CROZIER,
Captain, Ordnance Department, U. S. A.

The CHIEF OF ORDNANCE, UNITED STATES ARMY,
Washington, D. C.

(6327—Enc. 7)

Record of firing with Hotchkiss 4.72-inch rapid-fire gun at Sandy Hook

[Object of firing, to test working

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Instrumental velocity, 300 feet from muzzle.	Pressure, per square inch of bore.
		Kind.	Weight.	Kind.	Weight.			
1894.			*Lbs.* *Oz.*		*Lbs.* *Oz.*	° ′	*Feet.*	*Pounds.*
Nov. 20	1	French smokeless, B. N., 2 ounces rifle powder for igniter.	4 0	Shell, lot 504, weighted up with sand.	54 0	......	....	5, 6,285
			2 igniter.		1 0 sand.			
			4 2		55 0			
Nov. 20	2		7 0		53 12	......	....	12,762
			2 igniter.		1 4 sand.			
			7 2		55 0			
Nov. 20	3		8 0		54 4	......	....	5, 16,556
			2 igniter.		12 sand.			
			8 2		55 0			
Nov. 20	4		8 8		55 0	......	....	5, 18,160
Nov. 20	5		8 8		55 0	......	....	10, 18,691
Nov. 20	6		9 8		55 0	......	....	5, 22,757
Nov. 20	7		10 0		55 0	......	....	10, 24,292
Nov. 20	8		10 0		55 0	......	....	5, 24,024
Nov. 20	9		10 0		55 0	......	....	10, 24,802

[Object of firing, exhibition before the

Date.	No. of fire.	Powder kind.	Powder weight.	Projectile kind.	Projectile weight.	Elevation.	Instrumental velocity.	Pressure.
1894.								
Nov. 22	10	....	10 0	Lot 505	35 4	......	....	....
					1 0			
					36 4			

[Object of firing, to

Date.	No. of fire.	Powder kind.	Powder weight.	Projectile kind.	Projectile weight.	Elevation.	Instrumental velocity.	Pressure.
1895.								
Jan. 5	11	French smokeless, B. N.	10 0 2 igniter.	Shell, lot 505.	36 4	3 0	2,016 2,017	....
Jan. 5	12		10 0 2 igniter.		36 4	3 0	2,074 2,083	....
Jan. 5	13		10 0 2 igniter.	Shell, lot 504.	55 0	3 0	1,780 1,782	....
Jan. 5	14		10 0 2 igniter.		55 0	3 0	Lost. 1,885	....
Jan. 5	15		10 0 2 igniter.		55 0	3 0	1,879 1,882	....

[Object of firing,

Date.	No. of fire.	Powder kind.	Powder weight.	Projectile kind.	Projectile weight.	Elevation.	Instrumental velocity.	Pressure.
1895.								
Jan. 15	16 to 24	French smokeless, B. N.	10 0 2 igniter.	....	36 4	......	....	....

Proving Ground, from November 20, 1894, to February 19, 1895.

of carriage and determine charge.]

Recoil.	Counter recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Inches.	*Inches.*		
6¾	6¾	Three attempts failed to ignite charge. Cartridge removed and taken apart, and igniter found to have dropped to the bottom of the case; the cap was exploded. Case recapped and made up again. Many unburned grains from muzzle.	Gun mounted on its own carriage. Rounds 1 to 7, inclusive, fired to sea. Rounds 8 to 10, inclusive, fired into sand butt No. 2. It is all one man can do to close block, owing to its great weight.
8⅞	8⅞	Many unburned grains and a great quantity of flame issued from muzzle at discharge.	
9	9	The primer exploded but failed to ignite the charge. Case removed, recapped, and fired at first attempt.	
9⅜	9⅜		
9	9	Glycerin and water removed from cylinders and cylinders filled with pure glycerin.	
9	9		
9	9		
9	9		
9	9		

Board of Ordnance and Fortification.]

9	9		

obtain velocities.]

8¾			Gun star-gauged before this firing. Considerable smoke and flame issued from muzzle at each discharge.
8¾			
8¾			
8½			
8½			

to test rapidity.]

8½		Fired to note the place of striking. Number of rounds fired in 1 minute, 7. So much flame came out of the breech of the gun when block was opened (due to the slow combustion of this powder) that firing for rapidity was suspended after 1 minute 12 seconds, 8 rounds being fired.	Fired to sea. Elevation changes on firing. One of the cases was split near choke 8½ inches long and ¼ inch open.

Record of firing with Hotchkiss 4.72-inch rapid-fire gun at Sandy Hook Proving

[Object of firing,

Date.	No. of fire.	Powder.			Projectile.			Elevation.	Instrumental velocity, 300 feet from muzzle.	Pressure, per square inch of bore.
		Kind.	Weight.		Kind.	Weight.				
1895.			*Lbs.*	*Oz.*		*Lbs.*	*Oz.*	° ′	*Feet.*	*Pounds.*
Jan. 28	25	Sphero-hexagonal, U.F., lot 3.	10	0 2⅛ igniter.	....	36	4	......	....	15, less than 24,000
Jan. 28	26	Prismatic, W.V	15	0 2⅛ igniter.	....	36	4	......	....	5, less than 24,000
Jan. 28	27	U. F., lot 3	13	0 2⅛ igniter.	....	36	4	......	....	15, 28,186
Jan. 28	28	U. F., lot 3	15	0 2⅛ igniter.	....	36	4	......	....	15, 46,556
Jan. 29	29	U. F., lot 3	14	0 2⅛ igniter.	....	36	4	......	....	15, less than 32,000
Jan. 29	30	Sphero-hexagonal, I. B. E.	15	0 2⅛ igniter.	....	36	4	......	....	5, 36,667
Jan. 29	31	I. B. E	15	0 2⅛ igniter.	....	36	4	......	....	5, 36,356
Jan. 30	32	I. B. E	15	0 2⅛ igniter.	....	36	4	......	....	5, 37,511
Jan. 30	33	I. B. E	15	0 2⅛ igniter.	....	36	4	......	....	10, 36,467

[Object of firing,

1895.										
Feb. 19	34	I. B. E	15	0 2 igniter.	....	36	4	......	....	....
Feb. 19	35	I. B. E	15	0 2 igniter.	....	36	4	......	....	....
Feb. 19	36	I. B. E	15	0 2 igniter.	....	36	4	......	....	....

Ground, from November 20, 1894, to February 19, 1895—Continued.

to obtain pressure.]

Recoil.	Counter recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Inches.	*Inches.*		
8	....	....	An igniter of 2½ ounces rifle powder was placed loose on base of case over the cap. The powder was placed in a serge cartridge bag and put in the case, only 1 wad (felt) being used in front of powder.
8½	....	....	
8¾	....	....	
8¾	....	Case expanded so much as to cause difficulty in opening block.	
8½	....	Case extracted with difficulty	
8½	....	....	
8¾	....	....	
8¾	....	....	
8¾	....	....	

to test rapidity.]

....	....	....	The igniter, 2 ounces rifle powder, was sewed to the base of the bag so as to be directly over the primer. The powder was put in a serge cartridge bag and placed in the case. One wad was used, and the remaining space between the powder and shell was filled with dry hay. For the Board: Frank H. Phipps, Major, Ordnance Department, U. S. A., President. Frank Heath, Captain, Ordnance Department, commanding.
....	....	....	
....	....	Fired for pressure. Charge put up as in rounds 34 and 35. Gun burst, killing Lieut. F. P. Peck, Ordnance Department, the officer in charge of the firing. A portion of the breech end of the gun, weighing with breechblock 301 pounds, was thrown 300 feet to the rear. Head of cartridge case blown off. A portion of this head, together with some fragments of the gun, entered the body of Lieutenant Peck, causing his death. The photographs herewith show part of the gun which burst, and the character of the fracture. Pressure gauge could not be found.	

Star gauging of Hotchkiss 4.72-inch rapid-fire gun, Sandy Hook Proving Ground.

[4.72-inch ring and points. Temperature: Jan. 4, 1895, outside bore 30°, inside 34°; Feb. 23, 1895, outside bore 28°, inside 30°.]

LANDS.

From muzzle.	After 10 rounds, Jan. 4, 1895.	After 36 rounds, Feb. 23, 1895.	Increase.	From muzzle.	After 10 rounds, Jan. 4, 1895.	After 36 rounds, Feb. 23, 1895.	Increase.
Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
0	4.7250	4.7250	0.0000	90	4.7260	4.7260	0.0000
5	4.7250	4.7245	— .0005	95	4.7265	4.7260	— .0005
10	4.7250	4.7250	.0000	100	4.7265	4.7255	— .0010
15	4.7250	4.7250	.0000	105	4.7260	4.7260	.0000
20	4.7255	4.7250	— .0005	110	4.7260	4.7260	.0000
25	4.7260	4.7250	— .0010	115	4.7255	4.7260	.0005
30	4.7255	4.7250	— .0005	120	4.7255	4.7260	.0005
35	4.7260	4.7255	— .0005	125	4.7260	4.7260	.0000
40	4.7255	4.7250	— .0005	127	4.7260	4.7260	.0000
45	4.7260	4.7250	— .0010	129	4.7260	4.7260	.0000
50	4.7255	4.7250	— .0005	131	4.7260	4.7260	.0000
55	4.7260	4.7250	— .0010	133	4.7260	4.7260	.0000
60	4.7260	4.7250	— .0010	135	4.7270	4.7270	.0000
65	4.7260	4.7260	.0000	137	4.7320	4.7340	.0020
70	4.7260	4.7260	.0000	139	4.7400	4.7410	.0010
75	4.7260	4.7260	.0000	141	4.7480	4.7485	.0005
80	4.7255	4.7250	— .0005	143	4.7585	4.7590	.0005
85	4.7260	4.7250	— .0010	144	4.7670	4.7680	.0010

GROOVES.

0	4.8185	4.8190	0.0005	90	4.8185	4.8185	0.0000
5	4.8190	4.8195	.0005	95	4.8190	4.8190	.0000
10	4.8190	4.8190	.0000	100	4.8185	4.8185	.0000
15	4.8185	4.8190	.0003	105	4.8185	4.8185	.0000
20	4.8190	4.8195	.0005	110	4.8180	4.8180	.0000
25	4.8190	4.8190	.0000	115	4.8180	4.8175	— .0005
30	4.8200	4.8200	.0000	120	4.8175	4.8175	.0000
35	4.8200	4.8200	.0000	125	4.8175	4.8170	— .0005
40	4.8200	4.8200	.0000	127	4.8170	4.8170	.0000
45	4.8200	4.8195	— .0005	129	4.8180	4.8175	— .0005
50	4.8200	4.8200	.0000	131	4.8175	4.8170	— .0005
55	4.8195	4.8200	.0005	133	4.8180	4.8175	— .0005
60	4.8195	4.8200	.0005	135	4.8180	4.8175	— .0005
65	4.8190	4.8200	.0010	137	4.8180	4.8185	.0005
70	4.8190	4.8195	.0005	139	4.8180	4.8190	.0010
75	4.8190	4.8190	.0000	141	4.8190	4.8200	.0010
80	4.8185	4.8185	.0000	143	4.8195	4.8200	.0005
85	4.8185	4.8185	.0000	144	4.8200	4.8200	.0000

CHAMBER VERTICAL.

From breech.	After 10 rounds, Jan. 5, 1895.	After 36 rounds, Feb. 23, 1895.	Increase.	From breech.	After 10 rounds, Jan. 5, 1895.	After 36 rounds, Feb. 23, 1895.	Increase.
Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
9	5.3940	5.3950	0.0010	23	5.2500	5.2550	0.0050
10	5.3860	5.3850	— .0010	25	5.2330	5.2350	.0020
12	5.3770	5.3660	— .0010	27	5.2100	5.2120	.0020
13	5.3530	5.3550	.0020	29	5.1895	5.1900	.0005
15	5.3320	5.3350	.0030	31	5.1700	5.1700	.0000
17	5.3130	5.3150	.0020	33	5.0210	5.0320	.0110
19	5.2930	5.2950	.0020	35	4.9285	4.9300	.0015
21	5.2740	5.2760	.0020	37	4.8650	4.9300	.0650

CHAMBER HORIZONTAL.

From breech.	After 10 rounds, Jan. 5, 1895.	After 36 rounds, Feb. 23, 1895.	Increase.	From breech.	After 10 rounds, Jan. 5, 1895.	After 36 rounds, Feb. 23, 1895.	Increase.
Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
9	5.3940	5.4000	0.0060	23	5.2510	5.2550	0.0040
10	5.3860	5.3900	.0040	25	5.2310	5.2350	.0040
12	5.3780	5.3700	— .0080	27	5.2090	5.2120	.0030
13	5.3530	5.3600	.0070	29	5.1890	5.1890	.0000
15	5.3320	5.3350	.0030	31	5.1680	5.1700	.0020
17	5.3130	5.3150	.0020	33	5.0200	5.0300	.0100
19	5.2930	5.2960	.0030	35	4.9285	4.9300	.0015
21	5.2740	5.2760	.0020	37	4.8650	4.9300	.0650

When the star gauge is set to the 4.72-inch ring there is not throw enough to bring the points in contact with the walls of the chamber. To star gauge the chamber after the thirty-sixth round the points were brought in contact with the walls of the chamber and the reading on the gauge noted. The star gauge was then withdrawn and the distance across the points was calipered, the reading on the star gauge remaining the same.

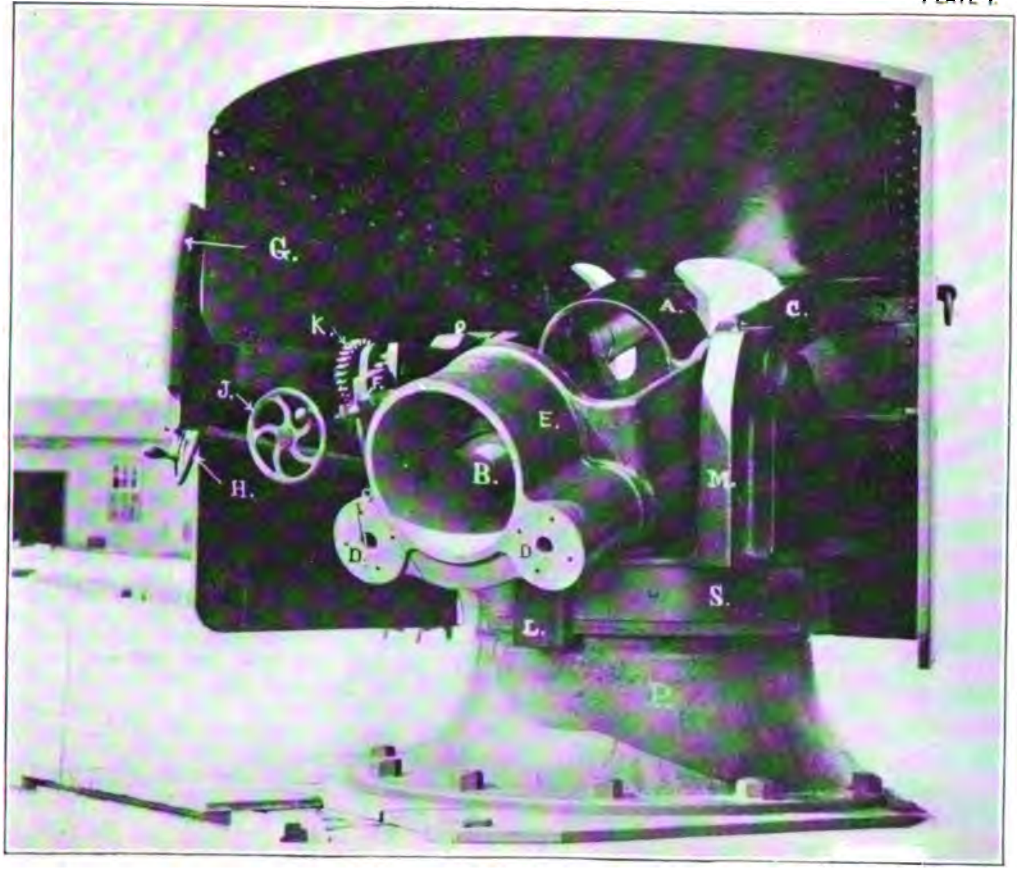
The gun was star gauged after the tenth round by Gregory Gerdom, jr., and after the thirty-sixth round by Gregory Gerdom, sr., owing to certain discrepancies in the results of the star gauging by the former after the thirty-sixth round.

The differences between the two star gaugings probably do not indicate the true amount of change.

The last star gauging is correct. The great difference of 0.0650 inch at the 37-inch is undoubtedly due to an error in the first star gauging.

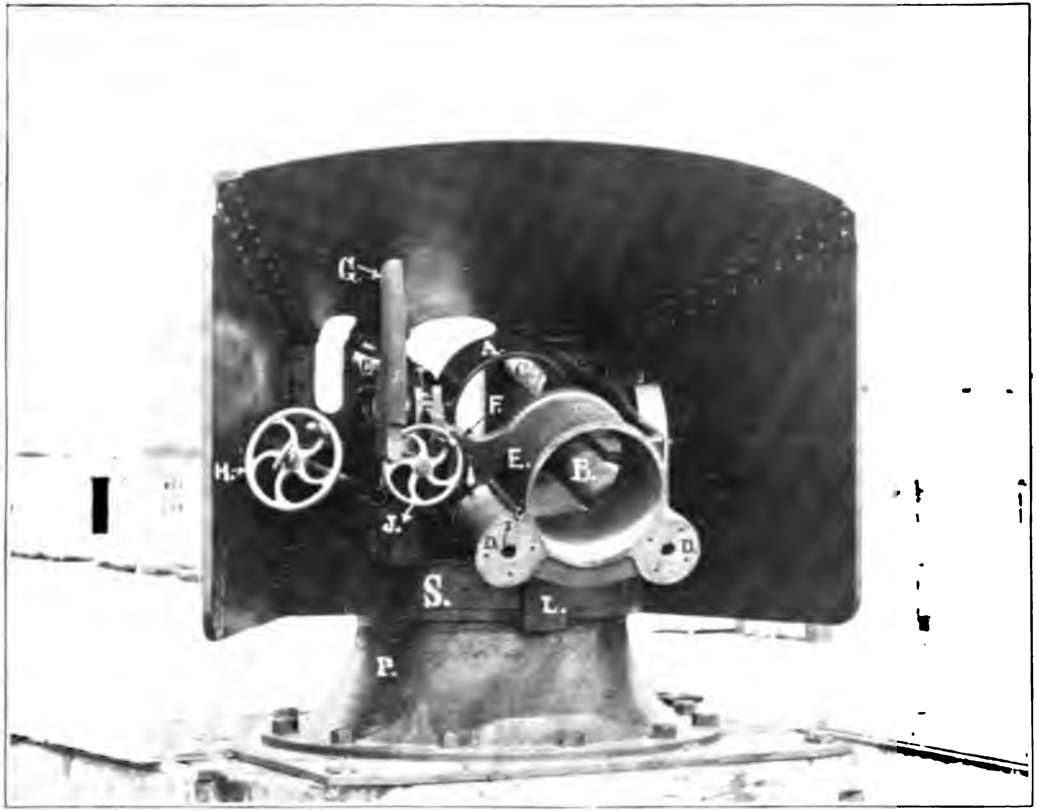
Charles B. Wheeler,
Lieutenant, Ordnance Department, U. S. A.

PLATE I.



Appendix 25, 1896.

PLATE II.



Appendix 25, 1896.

APPENDIX 26.

TRIAL OF SCHNEIDER 12-CM. (4.72-INCH) RAPID-FIRE GUN AND MOUNT.

(10 plates.)

THE ORDNANCE BOARD, U. S. A.,
NEW YORK ARSENAL,
GOVERNORS ISLAND, NEW YORK HARBOR,
New York City, February 28, 1896.

SIR: The following report of the test of a Schneider 4.72-inch rapid-fire gun and mount is respectfully submitted.

DESCRIPTION.

THE GUN.

The gun is of steel, and comprises—

A tube extending the whole length of the gun and inclosing the breech mechanism;

A jacket shrunk over the tube;

A series of hoops shrunk over the jacket and tube for about two-thirds the length of the gun.

Two of these hoops have dovetailed projections which secure the gun to the hydraulic brakes.

The chamber is conical for the greater portion of its length, succeeded by a short cylindrical part for the neck of the case. This cylindrical part is connected with the rifling by the forcing cone.

BREECH MECHANISM.

(Plates I and II.)

The breech mechanism comprises the breechblock, the console, the extractor and its parts, and the maneuvering and firing mechanisms.

The breechblock Y is of steel, and has upon its cylindrical surface three plain and three threaded sectors, and two grooves in which work the guides on the console during the translation of the block. Recessed along its axis is a chamber for the firing pin, and upon its rear surface are secured the handle K and maneuvering lever A.

The console G is of brass, secured to the face of the breech by the hinge pin E. By means of a double latch L it can be locked either to the gun or the breechblock, depending on the position of the latter.

The extractor and its parts comprise the extractor proper B, a toothed sector D, a slide bracket B′, and a finger F. The extractor proper is a rack having at its front end a claw. In the rack the toothed sector constantly engages. The slide bracket is bolted to the face of the breech, and its upper surface, with the lower part of the screw box, constitutes the guide for the extractor. The toothed sector turns on the hinge pin and is actuated by the finger drawing out the extractor. The finger F is a vertical pin secured to the console, and transmits the rotation of the console to the toothed sector by engaging in a recess *d* in the latter. It has upon its upper surface a projection F, which bears constantly upon the incline *e* upon the hinge pin. This incline withdraws the finger from its recess during the last part of the operation of swinging aside the block and console, when the cartridge case has been sufficiently drawn out to be removed by hand.

The maneuvering parts comprise the operating lever A, the locking lever *k*, the handle K, the locking stud J, and the stop bolts M.

The operating lever A is bolted to the block and recessed for the locking lever and sear of the firing mechanism. The locking lever *k* is pivoted about an axis in the operating lever, and is forced outward by a spring *b*. It engages with the locking stud and also in a groove cut in the face of the breech. The locking stud is secured to the face of the breech and provided with a spring *l* and catch spring *m*. The outer surface of this stud has a shoulder against which bears the locking lever and an incline over which it slides prior to engaging. During recoil the stud is forced relatively forward and inward, releasing the locking lever and permitting the catch spring *m* to engage in a notch in it, keeping the stud forward. In this position the operating lever can be readily rotated. When not firing the stud must be forced inward by pressure before the block can be rotated. The handle K is used to withdraw the breechblock. The stop bolts M limit the rotation of the operating lever. After firing, to operate the breech mechanism the operator grasps the operating and locking levers with his right hand and the handle K with his left. By pressure on the locking lever it is released from the groove in the face of the breech and the operating lever is then rotated to the left one-sixth of a turn, unlocking the breechblock. By pulling on the handle K and the operating lever the block is withdrawn until it strikes the faces of the guides on the console, the shock of which frees the double latch pin and permits it to engage with the block. The combined block and console are now free to rotate about the hinge pin. By pulling on the operating lever the block and console rotate to the left; the finger F strikes against its recess in the toothed sector, the shock loosening the empty case. Further rotation causes the finger through the toothed sector to draw out the extractor, and at the same time the slope on the hinge pin withdraws the finger out of its recess. Before the rotation is completed the finger leaves its recess, becoming disengaged from the toothed sector. The empty case is now sufficiently withdrawn to permit of its removal by hand.

The gun is adapted to either percussion or electrical firing.

The percussion firing mechanism is self-cocking, and comprises essentially a firing pin, sear, and trigger. The firing pin N and its spring *n* are recessed in the axis of the block. The pin has in front a retractor spring *p* to keep its point flush with the face of the block, and in rear a tail P, under which bears the sear R. The sear is recessed in the operating lever and rotates about an inclined axis *d*, which, by a projection in one and groove in the other, when the breech mechanism is locked, forms a common axis with that of the trigger. The trigger S is directly underneath the sear when the block is locked, and rotates about an inclined axis *e* fixed in a bracket bolted to the face of the breech. The sear and trigger are provided with springs which bring all the parts to their initial position after firing. Pulling the lanyard (the block being locked) rotates the common axis of the sear and trigger, draws out the point of the sear, bringing with it the firing pin, and the latter is released, firing the gun as soon as the sear ceases to bear under the tail of the firing pin. Pulling the lanyard, the block, not being locked, transmits no motion whatever from the trigger to the sear, since their axes are not then common.

In order to fire electrically the parts constituting the firing pin and sear are replaced by insulated conductors. One terminal of the firing battery is in contact with the mount and the other with an insulated binding post on the face of the breech. When the block is locked the conductor in the operating handle makes contact with the binding post on the face of the breech and the circuit is made complete by a button circuit closer held by the operator.

Nomenclature, Plate I.

Name.	Parts.	Name.	Parts.
G—Console	1	S—Trigger	5
E—Hinge pin	5	B—Extractor	9
Y—Breechblock	9	J—Locking stud	3
A—Operating lever	5	L—Double latch	10
N—Firing pin	5	M—Stop bolts (2).	
R—Sear	7		

THE MOUNT.

(Plates III, IV, V, VI, VII.)

The mount comprises essentially a cradle, chassis, racer, bedplate, shield, and training mechanism.

The cradle A comprises a fixed part and a recoiling part.

The fixed part consists of two side beams *d*, connected with each other by a central transom *a* underneath the gun. These beams have trunnions, which have their bearings on the chassis and support the weight of the gun and cradle. Projections at the forward and rear ends of the beams furnish points of attachment for the piston rods of the hydraulic brakes and the compressor rod of the recuperator springs.

The recoil parts comprise the hydraulic brakes and the recuperator springs.

The hydraulic brakes are symmetrically placed one on each side of the gun, and operate in identically the same manner. Each brake is a solid casting and comprises a front and a rear cylinder, F and F′, each having its own piston and rod. The gun is attached to these brakes by dovetailed projections. Directly underneath the brakes, at their forward ends, are projections, *b*, which serve as abutments for the recuperator springs, *r*, mounted on the compressor rod K. This rod is formed with a head at its forward end which bears against a projection in the side beam, and at its rear end with a screwed part which works in a long nut *d* attached to the same beam. This arrangement permits of giving an initial compression to the springs. Volute springs are employed, separated by disks which prevent them from getting foul of each other. Each recuperator has ten springs.

After firing the gun and brakes recoil. The pistons remain immovable. Liquid is in consequence forced from the front to the rear of each piston through grooves cut in the cylinders. These grooves have a variable section calculated to give a constant resistance during recoil. The formation of a vacuum in the front cylinder, due to the exit of the piston rod, is obviated by having the counter stem of the rear piston enter this cylinder during recoil. The return to battery is obtained from the power stored up in the recuperator springs during recoil, the hydraulic brakes regulating the return, and the buffers *m* taking up any shock. The maximum extent of recoil is 8.3 inches.

The chassis *c* consists of two side frames of cast steel bolted to the racer. The left side frame has cast with it a bracket which forms clearings for the training mechanisms and a point of attachment for the shoulder piece H.

The racer D is a cast-steel plate having at the center the recess for the pivot of the bedplate, and on its underside the upper roller path. The racer turns on 24 conical rollers held in place by two concentric rings, in which the spindles of the rollers bear. The racer is provided with a dust guard, S, for the roller paths, and a locking bolt, O, for clamping the gun and mount to the bedplate.

The bedplate E is bolted to the concrete foundation. Its upper surface constitutes the lower roller path. A toothed ring is attached to the bedplate for training in azimuth.

The shield consists of two side plates, a front plate, and a hood, bolted together by angle irons. The shield is fastened to the racer in front and on the sides by strong angle brackets. The thickness of the side and front plates is 2.7 inches and of the hood 1.2 inches.

Training in elevation is obtained by means of a handwheel, P, which rotates a horizontal shaft mounted in a bracket on the left side frame of the chassis. This shaft has at its far extremity a worm, engaging a worm wheel, W, which rotates on the same shaft a pinion, R, that engages with a toothed sector attached to the cradle. A friction clutch permits of slight displacement of the elevation during recoil and prevents injury to the parts from shock.

Training in direction is given by a handwheel, J, which works a worm on the same shaft. This screw rotates a worm wheel on a vertical axis having at its lower extremity a pinion, L, which engages with the toothed ring on the bedplate.

The sights are very simple. The breech sight consists of a vertical bar and a crosspiece attached to it. The bar fits in a socket attached to the cradle and is operated by a pinion engaging with a rack on the bar. The bar has a scale of equal parts in millimeters, graduated on it. The crosspiece is graduated in millimeters and deflection is given by a milled head and screw. Its upper surface is interrupted by a small indent forming the open sight. The front sight is a piece of pointed iron fastened to the cradle.

The training mechanisms and sights are on the left side of the gun, and are readily operated by one man.

AMMUNITION.

(Plate VIII.)

The ammunition is fixed, and is contained in a metallic cartridge case. This case is of brass drawn out, and is recessed in its head for percussion or electric primers.

The powder is either smokeless B. N. or brown prismatic. A priming of black powder is required with the former. The projectile is forced into the open end of the case as far as the rotating band. The projectiles are of three kinds—ordinary cast iron, chrome steel, and shrapnel.

The plate shows the operations used in forcing the projectile to its seat in the case and one of the cases already fixed.

The following are the principal particulars with respect to the gun and mount, furnished by the Schneider Company:

Weight of gun	tons..	3.2
Length of gun	inches..	236.2
Length of gun in calibers		50
Weight of projectile	pounds..	48.4
Powder charge, brown prismatic	do....	26.5
Powder charge, smokeless B. N	do....	18.2
Weight of loaded cartridge case	do....	87
Initial velocity using brown prismatic	feet per second..	2,346
Initial velocity using B. N. smokeless	do....	2,658
Thickness of iron plate that can be penetrated at muzzle with initial velocity 2,658 feet per second	inches..	12
Weight of mount without shield	pounds..	6,280
Weight of shield	do....	8,710

The programme adopted for the test of 4.72-inch rapid-fire guns is as follows:

Each gun to be carefully examined by the Board. The number of parts of the breech mechanism in each, their strength, simplicity, and certainty of action to be noted; also the ease, safety, and certainty of the breech mechanism as a whole. Note especially the action of the firing pin and extractor, and the maximum outward position of the cartridge when it can be pushed home by the breechblock. During this examination 20 rounds to be fired at will from each gun.

VELOCITY.

Five rounds to be fired for velocity from each gun with full charges.

ACCURACY.

Ten rounds to be fired at each range of 1 mile and 3,000 yards, the same conditions of aiming being repeated at each round with the guns, respectively, and the mean deviations determined.

RAPIDITY.

Determine the number of rounds that can be fired in 3 minutes, noting carefully during the firing, and especially at the termination of the test, the condition of the guns as regards heat and ease and certainty of action.

Two detachments of men to be used, the first to be relieved in 1 minute 30 seconds. The above test to be repeated if found necessary by the Board.

RAPIDITY WITH ACCURACY.

Fire 10 aimed shots as rapidly as possible at the 1,000-yard and 1-mile targets; also 10 aimed shots at targets in same line and ranges of 500 yards and 1,000 yards alternately; also 10 aimed shots alternately at targets at about 500 yards range, placed about 75 feet apart.

TEST OF SHRAPNEL.

Against steel plates.—Two shrapnel of each kind to be fitted with Frankford Arsenal sensitive-point fuses and fired to burst while passing through a screen placed in front of a 1¼-inch rolled-steel plate located about 150 feet from the gun, the effect on the plate of the fragments to be noted. The charge in above test to be such as to give a muzzle velocity equal to the remaining velocity at 1 mile when full charges are used.

For dispersion.—Three shrapnel of each kind to be fitted with Frankford Arsenal sensitive-point fuses and fired to burst while passing through a screen placed about 100 feet in front of the 1,000-yard target, and the number of hits and their character as regards penetration, etc., to be observed.

CANISTER.

Two canister of each kind to be fired against a 1½-inch rolled-steel plate to be located about 300 yards from the gun, and effects on the plate to be noted; also two canister of each kind to be fired against a screen 26 by 20 feet located about 100 yards from the gun, the number of hits at each round to be noted.

RAPIDITY WITH ACCURACY AGAINST A MOVING TARGET.

A boat on which is placed a suitable target to be towed across the line of fire at the rate of about 6 miles an hour. While within ranges of from 500 to 2,000 yards each gun to be fired aimed shots as rapidly as possible for 3 minutes, the number of hits to be noted.

DUST.

The mechanism of each gun to be exposed to a blast of fine dust in such manner as to insure its being uniformly and equally covered with the dust, after which 20 rounds to be fired from each gun as rapidly as possible.

RUST.

Five rounds to be fired after the mechanism of each gun has been rusted in a thorough and uniform manner.

EXCESSIVE CHARGES.

Each gun to be fired five charges with gradually increasing pressures, the maximum being about 33⅓ per cent above the service pressure.

DEFECTIVE CARTRIDGES.

Each gun to be tested with defective cartridges in the same manner as is usual in the trial of small arms.

ENDURANCE.

The guns which successfully pass the above test to be fired 100 rounds for endurance, during which the general efficiency of the gun and its mount, also the regularity of action of the fuses, will be carefully observed.

If at any time during the test a gun shows a marked inferiority as compared with the others, the test of this gun will be suspended.

The test in accordance with the above programme was commenced November 19, 1894. Commandant Kreyder, of the French army, was present throughout the test as a representative of the manufacturers.

The action of the mechanism in manipulation and deliberate firing was satisfactory. The number of parts of the mechanism is 61, including 9 springs. This number is greater than is usually found in the best modern mechanisms for rapid-fire guns. The use of two levers in operating the breechblock is a source of some confusion except in the hands of a well-trained operator. The extractor has very little surplus power over that required under normal conditions. In an emergency this might be a source of some difficulty. Its action is simply to loosen the case, after which the latter is withdrawn by hand. In order that the extractor may move forward with the rim of the cartridge in loading, it is necessary that the breechblock be wide open and held in this position by the hand, otherwise the extractor will stop the cartridge before its head reaches the face of the breech, the block can not then be closed and the cartridge must be withdrawn for a second trial. This difficulty affects the rapidity of fire. At the termination of the operation of closing the block the right arm of the operator, as well as a considerable portion of his body, is in rear of the breech of the gun. This is considered by the Board a very objectionable feature in a rapid-fire gun. It is particularly objectionable with this gun for the reason that the extractor guide extends to the rear of the breech about 11 inches. The operator in manipulating the block is liable to stand close to the end of this guide. If, while in this position, the piece were discharged, in all probability a fatal blow would be received from the guide by the operator during the recoil. In the excitement of rapid firing the events as above noted might easily occur. Premature explosion of the cartridge is prevented (1) by the retractor spring *p*, which keeps the point of the firing pin always flush with the face of the block, except at the instant when the mainspring is in action; (2) the pulling of the lanyard will transmit no motion whatever from the trigger to the sear until their axes are coincident, and these axes can not be coincident until the breechblock is closed and locked. These safety devices appear to be efficient and satisfactory.

VELOCITY.

The highest velocity obtained was 2,570 feet per second, the pressure being 35,600 pounds per square inch. This pressure was somewhat greater than the standard for the gun; the charge was therefore reduced from 18 pounds 12 ounces of French smokeless *B. N.* powder to 18 pounds 8 ounces. With the latter charge the pressure was reduced to about 33,000 pounds, and the velocity to 2,537 feet per second.

ACCURACY.

At 1-mile range the mean vertical deviation from the center of impact was 2.3 feet, the mean horizontal deviation 1.88 feet, and the mean deviation 2.99 feet.

The target is shown on Pl. IX.

RAPIDITY.

The number of rounds fired in 3 minutes was 19, of which 8 were fired in the first minute. The gun was served by 2 officers and 5 men. The officers operated the block and fired the gun; 4 men served ammunition and inserted the cartridges and 1 man took charge of the empty cases. The rapidity was noticeably affected by the lack of power in the extractor; by the fact that it was necessary to push the projectile well up into the rifling in order to close the block, making the latter part of the block's motion somewhat difficult; by the necessity of keeping the block open to its fullest extent during the insertion of the cartridge, and by the care required before pulling the lanyard to insure that the officer operating the block was out of the way. During the test the nuts of the elevating friction clamp became loose, causing a delay of 10 minutes to tighten them. After this had been done and during the remainder of the test there was a tendency of the gun to increase its elevation, which was, however, controlled by the operator.

DUST.

For the dust test the mechanism was thoroughly cleaned and lightly oiled and breechblock closed and locked. The breech was then surrounded by a wooden box with a curtain in front, which was tied around the gun. On the box was a hopper containing about two-thirds of a cubic foot of finely pulverized sand. The dust runs through a slot in a wooden pipe to which is connected a pipe from a blacksmith's bellows, by which means the dust is blown with considerable pressure against the breech. The bellows was pumped 8 minutes, about half of the dust being used. On opening the box the breech was found thoroughly covered with dust, which had also penetrated all of its parts. The hands only were used in cleaning off the dust until the block was opened, when a gun sponge was used. To open the block it was found necessary to disconnect the extractor from it. This was accomplished by lifting the finger by means of a wire from its engagement with the toothed sector. The block was dismounted from the console and the dust brushed off. The chamber and bore were wiped out with the gun sponge, and the sponge was used to brush the dust out of the breech threads and extractor guide. Total time required for the above operations and to fire 5 rounds, 41 minutes and 44 seconds.

DEFECTIVE CARTRIDGES.

But one defective cartridge was fired. Before the test the gun was thoroughly cleaned and oiled. The case was prepared by filing four slots obliquely through the edge of the rim at an angle of about 40° with the axis, so as just to touch the cavity of the case. The slots being at the extremities of two diameters, at right angles with each other, the cartridge was placed in the gun so that the solid part of the head came opposite the extractor. Upon discharge a large quantity of gas escaped through the block, being blown about 100 feet to the rear. The console latch was unlatched and the block was slightly rotated. The block could not be opened by hand, but required blows on the lever by a mallet to rotate it. After rotation, the block was withdrawn by blows from the muzzle with a rammer. The claw of the extractor was found broken off, rendering the latter unserviceable. The fracture was covered with brass, showing that the extractor had been broken by the escaping gases. The holes in the slots of the cartridge case were increased to about ½-inch diameter. A wedge-shaped imprint of each slot covered with brass was found on the face of the breechblock.

RAPIDITY WITH ACCURACY.

Before this firing a new extractor was made to take the place of the one broken in the defective test. For combined accuracy and rapidity a single target of 10 rounds was taken at 1 mile, resulting as follows: Mean vertical deviation from center of impact, 1.85 feet; mean horizontal deviation, 2.05 feet; and mean deviation from center of impact, 2.76 feet. The 10 rounds were fired in 4 minutes and 8 seconds.

DEFECTIVE PRIMERS.

The "blowback" or defective primer test was made by thinning the metal of the primers sufficiently to insure that the primer would break at discharge and allow the gases to penetrate into the mechanism. One round was fired, resulting in the blowing out of the firing pin and the twisting and bending of the firing-pin spring. To resume the firings it was necessary to provide a new firing pin and spring.

EXCESSIVE PRESSURE.

As the pressures required for this test could not be obtained with the B. N. smokeless powder, Du Pont's sphero-hexagonal, A. F., lot 3, was used, the charge varying from 12 pounds to 17 pounds. The high pressures obtained were as follows: 42,000 pounds, 50,286 pounds, and 53,489 pounds per square inch. No accident of any kind occurred during this test.

As the Board considered that a sufficient knowledge of the Schneider mechanism had been obtained by the experiments above enumerated, the further test of the system was at this point suspended.

CARRIAGE.

With the exceptions noted in the rapidity test, the working of the carriage throughout the firing was satisfactory.

FRANK H. PHIPPS,
Major, Ordnance Department, U. S. A., President.
FRANK HEATH,
Captain, Ordnance Department, U. S. A.
J. C. AYRES,
Captain, Ordnance Department, U. S. A.
WILLIAM CROZIER,
Captain, Ordnance Department, U. S. A.

The CHIEF OF ORDNANCE, UNITED STATES ARMY,
Washington, D. C.

(4066—Enc. 10)

Record of firing with Schneider 4.72-inch rapid-fire gun at Sandy Hook

[Object of firing, to test working of

Date.	No. of fire.	Powder.			Projectile.			Elevation.	Instrumental velocity, 275 feet from muzzle.	Pressure per square inch of bore.	Pressure (French gauge).	Deflection, left.
		Kind.	Weight.		Kind.	Weight.						
			Lbs.	*Oz.*		*Lbs.*	*Oz.*	° '	*Feet.*	*Pounds.*	*Atmospheres.*	*Points.*
1894. Nov. 19	1	French smokeless, B. N., 2-ounce igniter used with each charge.	6	0	Shell, lot 590, weighted up with sand.	48	0			10, 5,853		
Nov. 20	2		10	0		48	0			5, 9,833		
Nov. 20	3		12	0		48	8			10, 12,933		
Nov. 20	4		13	0		48	8			10, 15,155		
Nov. 20	5		14	8		48	8			10, 19,100		
Nov. 20	6		15	8		48	8			5, 21,043		
Nov. 20	7		16	8		48	8			10, 24,071		
Nov. 20	8		18	4		48	8			10, 29,862		
Nov. 21	9		18	4		48	8			5, 31,680		
Nov. 21	10		18	4		48	8			10, 30,213		

[Object of firing, exhibition of gun before

1894. Nov. 22	11	B. N.	18	4		48	8					

Proving Ground, from November 19, 1894, to January 4, 1895.

carriage and determine charge.]

Recoil.	Counter recoil.	Wind, strength, and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Inches.	*Inches.*			
6⅛	6⅛	Wind not taken; barometer, 30.09; thermometer, 45°; humidity, 64.	Breechblock rotated with some difficulty in closing.	Gun mounted on its own carriage. Rounds 1 to 7, inclusive, fired to sea. Rounds 8 to 10, inclusive, fired into sand butt No. 2. A great quantity of unburned grains of powder found in front of muzzle at nearly every round. As the charge increases the unburned grains of powder and flame get less. There is nearly as much smoke with this powder as with ordinary brown powder. No emptying hole in the cylinders.
7¾	7¾	Wind not taken; barometer, 30.77; thermometer, 36°; humidity, 60°.	The hand of one of the men was caught between the rim of cartridge case and rear end of guide, cutting it very badly.	
7¾	7¾		Sear failed to engage twice	
8	8		Sear failed to engage and had to be pushed in place by hand, probably caused by cosmic around spring. The trigger arm also found slightly bent. Put in working order by a machinist.	
8¼	8¼		....	
8¼	8¼		....	
8¼	8¼		....	
8⅝	8⅝		....	
8½	8½	Wind from right and rear, 45°, 8 miles an hour; barometer, 30.33; thermometer, 47°; humidity, 100.	....	
8½	8½		....	

the Board of Ordnance and Fortification.]

8½	8½	Wind from right and rear, 15°, 18 miles an hour; barometer, 30.43; thermometer, 49°; humidity, 67.	....	

Record of firing with Schneider 4.72-inch rapid-fire gun at Sandy Hook

[Object of firing, to test working of

Date.	No. of fire.	Powder.			Projectile.			Elevation.	Instrumental velocity, 275 feet from muzzle.	Pressure per square inch of bore.	Pressure (French gauge).	Deflection, left.
		Kind.	Weight.		Kind.	Weight.						
			Lbs.	*Oz.*		*Lbs.*	*Oz.*	° ′	*Feet.*	*Pounds.*	*Atmospheres.*	*Points.*
1894. Nov. 19	1	French smokeless, B. N., 2-ounce igniter used with each charge.	6	0	Shell, lot 590, weighted up with sand.	48	0	....	....	10, 5,853	....	....
Nov. 20	2		10	0		48	0	....	....	5, 9,833	....	....
Nov. 20	3		12	0		48	8	....	....	10, 12,933	....	....
Nov. 20	4		13	0		48	8	....	....	10, 15,155	....	....
Nov. 20	5		14	8		48	8	....	....	10, 19,100	....	....
Nov. 20	6		15	8		48	8	....	....	5, 21,043	....	....
Nov. 20	7		16	8		48	8	....	....	10, 24,071	....	....
Nov. 20	8		18	4		48	8	....	....	10, 29,862	....	....
Nov. 21	9		18	4		48	8	....	....	5, 31,680	....	....
Nov. 21	10		18	4		48	8	....	....	10, 30,213	....	....

[Object of firing, exhibition of gun before

1894. Nov. 22	11	B. N..	18	4	....	48	8	....	....	....	....	....

Proving Ground, from November 19, 1894, to January 4, 1895.

carriage and determine charge.]

Recoil.	Counter recoil.	Wind, strength, and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Inches.	*Inches.*			
6⅛	6⅛	Wind not taken; barometer, 30.09; thermometer, 45°; humidity, 64.	Breechblock rotated with some difficulty in closing.	Gun mounted on its own carriage. Rounds 1 to 7, inclusive, fired to sea. Rounds 8 to 10, inclusive, fired into sand butt No. 2. A great quantity of unburned grains of powder found in front of muzzle at nearly every round. As the charge increases the unburned grains of powder and flame get less. There is nearly as much smoke with this powder as with ordinary brown powder. No emptying hole in the cylinders.
7¾	7¾	Wind not taken; barometer, 30.77; thermometer, 36°; humidity, 60°.	The hand of one of the men was caught between the rim of cartridge case and rear end of guide, cutting it very badly.	
7¾	7¾		Sear failed to engage twice	
8	8		Sear failed to engage and had to be pushed in place by hand, probably caused by cosmic around spring. The trigger arm also found slightly bent. Put in working order by a machinist.	
8¼	8¼		....	
8¼	8¼		....	
8¼	8¼		....	
8⅝	8⅝		....	
8⅛	8⅛	Wind from right and rear, 45°, 8 miles an hour; barometer, 30.83; thermometer, 47°; humidity, 100.	....	
8⅛	8⅛		....	

the Board of Ordnance and Fortification.]

8⅛	8⅛	Wind from right and rear, 15°, 18 miles an hour; barometer, 30.43; thermometer, 49°; humidity, 67.	....	

Record of firing with Schneider 4.72-inch rapid-fire gun at Sandy Hook Proving

[Object of firing, to determine charge,

Date.	No. of fire.	Powder.			Projectile.			Elevation.		Instrumental velocity, 275 feet from muzzle.	Pressure per square inch of bore.	Pressure (French gauge).	Deflection, left.
		Kind.	Weight.		Kind.	Weight.							
			Lbs.	*Oz.*		*Lbs.*	*Oz.*	°	'	*Feet.*	*Pounds.*	*Atmospheres.*	*Points.*
1894.													
Dec. 13	12	French smokeless, B. N.	18	4	Shell, lot 590.	48	8	....	....	2,445 2,445	....	....	....
Dec. 13	13		18	4		48	8	....	....	2,492 2,498	5, 31,300	2,465 2,465 2,315 2,419	....
Dec. 13	14		18	4		48	8	....	....	2,543 2,545	10, 32,800	2,686 2,813 2,657 2,771	....
Dec. 14	15		18	12		48	8	....	....	2,555 2,557	5, 35,633	2,987 2,943 2,957 2,943	....
Dec. 14	16		18	12		48	8	....	....	2,567 2,573	10, 34,446	2,870 2,972 2,928 2,899	....
Dec. 15	17		18	8		48	8	....	....	2,487 2,508	5, 33,356	2,602 2,657 2,615 2,589	....
Dec. 15	18		18	8		48	8	....	....	2,526 2,548	10, 32,883	2,799 2,799 2,799 2,657	....

[Object of firing, to test

1894													
Dec. 18	19	French smokeless, B. N.	18	8	Shell, lot 590.	48	8	1	14 quadrant. 10 mm. by sight.	....	....	....	2
Dec. 18	20		18	8		48	8		10½ mm. by sight.	....	....	....	3
Dec. 18	21 to 30		18	8		48	8	 1	10½ mm. by sight. 04½ quadrant.	....	....	....	3

Ground, from November 19, 1894, to January 4, 1895—Continued.

using French and service gauges.]

Recoil.	Counter recoil.	Wind, strength, and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Inches.	*Inches.*			
......	......	Wind from right and rear, 15°, 22 miles an hour; barometer, 30.05; thermometer, 45°; humidity, 71.	....	A steel disk containing 4 compression cylinders (Schneider) placed in rear of cartridge case. Pressure gauge for field gun put in loose. Fired into sand butt No. 2.
......	......		....	
......	......		....	
......	......	Wind from right and front, 20°, 20 miles an hour; barometer, 30.20; thermometer, 45°; humidity, 100.	....	
......	......		....	
......	......	Wind from right and rear, 30°, 18 miles an hour; barometer, 30.30; thermometer, 48°; humidity, 79.	....	
......	......		....	

gun for accuracy at 1 mile.]

Recoil.	Counter recoil.	Wind, strength, and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
......	......	Wind from right and rear, 10°, 12 miles an hour; barometer, 30.41; thermometer, 37°; humidity, 48.	Struck target 4 feet 3 inches below and 3 feet 9 inches left of center.	Aimed at the upper left-hand corner of target. Elevation verified each time by quadrant.
......	......		Struck target 4 feet 4 inches below and 6 feet 5 inches right of center.	
......	......		Round 21 first to count on target.	

TARGET.

No. of round.	From center of target.				From center of impact.			
	Vertical.		Horizontal.		Vertical.		Horizontal.	
	Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.
21	0		5.5	.....	.....	.300	.517	.....
22	.....	.25	6.5	.....	.....	.559	1.517	.....
23	.....	5.25	3.5	.....	.....	5.559	.....	1.483
24	.....	2.5	1	.....	.....	2.809	.....	3.983
25	0		6.5	.....	.....	.309	1.517	.....
26	1.75	.....	4.5	.....	1.441	.....	.....	.483
27	3.5	.....	1.5	.....	3.101	.....	.....	3.483
28	.....	.66	9.33	.....	.....	.969	4.847	.....
29	1.5	.....	5.75	.....	1.191	.....	.767	.....
30	5	.....	5.75	.....	4.691	.....	.767	.....

	Feet.
Center of impact:	
Above	0.309
Right	4.983
Mean vertical deviation from center of impact...........	2.103
Mean horizontal deviation from center of impact...........	1.886
Mean deviation from center of impact........	2.825

Record of firing with Schneider 4.72-inch rapid-fire gun at Sandy Hook Proving

[Object of firing, to

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Instrumental velocity, 275 feet from muzzle	Pressure per square inch of bore.	Pressure (French gauge).	Deflection, left.
		Kind.	Weight.	Kind.	Weight.					
			Lbs. Oz.		*Lbs. Oz.*	° ′	*Feet.*	*Pounds.*	*Atmospheres.*	*Points.*
1894. Dec. 20	31	French smokeless, B.N.	18 4	Shell, lot 490, weighted up with sand.	48 8					
Dec. 20	32		18 4		48 8					
Dec. 20	33		18 4		48 8					
Dec. 20	34		18 4		48 8					
Dec. 20	35		18 4		48 8					
Dec. 20	36		18 4		48 8					
Dec. 20	37		18 4		48 8					
Dec. 20	38		18 4		48 8					
Dec. 20	39		18 4		48 8					
Dec. 20	40		18 4		48 8					
Dec. 20	41		18 4		48 8					
Dec. 20	42		18 8		48 8					
Dec. 20	43		18 8		48 8					
Dec. 20	44		18 8		48 8					
Dec. 20	45		18 8		48 8					
Dec. 20	46		18 8		48 8					
Dec. 20	47		18 8		48 8					
Dec. 20	48		18 8		48 8					
Dec. 20	49		18 8		48 8					
Dec. 20	50		18 8		48 8					

[Object of fir-

1894. Dec. 21	51 to 55	French smokeless, B. N.	18 8	......	48 8					

Ground, from November 19, 1894, to January 4, 1895—Continued.

test gun for rapidity.]

Recoil.	Counter recoil.	Wind, strength, and direction.	General remarks.
Inches.	*Inches.*		
......	......	Wind from left, 14 miles an hour; barometer, 30.40; thermometer, 49°; humidity, 79.	Fired to note the place of striking. Started with breechblock closed, ready to pull lanyard. Gun served by 2 officers and 5 men, 4 men to serve and insert the cartridge and 1 to dispose of the empty cases. Lieutenants Peck and Ruggles operated the block and fired the gun. It is noticeable in operating the block that the extractor has not much power. The rotating bands are well seated in the rifling when the cartridge is in place, making the latter part of the motion of closing the block often difficult. It is necessary in order that the extractor may move forward with the rim of the cartridge in inserting that the breechblock be opened wide and held by the hand, otherwise the extractor will stop the cartridge before its head reaches the face of the breech; the block can not then be closed on it, and the cartridge must be pulled back and the breech opened wide. The slow firing during the last 2 minutes was due partially to this cause and partially to the stiff working of block from fouling. At the eighth round the breech of the gun dropped several inches, and the firing was stopped to examine the carriage. The nuts holding the elevating friction clamp became loose, causing a delay of about 10 minutes. During the remainder of the firing the elevation gradually increased probably through about 5°, but the elevation was adjusted while the firing was in progress. One feature of the breech mechanism which is thought particularly objectionable is the extractor guide. This guide, of rectangular cross section and open at the top, extends to the rear of the breech about 11¼ inches. As a consequence the cannoneer operating the breech mechanism has to stand so close to the extractor guide that it is necessary for him to jump well out of the way to avoid being struck by the latter when the gun recoils. Should the piece be discharged before he is thus well out of the way (either through forgetfulness on his part or on the part of the one who pulls the lanyard, due to the excitement of rapid firing) he would in all probability be killed by the blow received in the abdomen. Number of rounds fired in 1 minute, 8. Number of rounds fired in 3 minutes, 19.
......	......		
......	......		
......	......		
......	......		
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......	......		
......	......		
......	......		

ing, dust test.]

Recoil.	Counter recoil.	Wind, strength, and direction.	General remarks.
......	......	Wind from right and rear, 20°, 17 miles an hour; barometer, 30.41; thermometer, 49°; humidity, 73.	The breech mechanism was thoroughly cleaned and lightly oiled before dusting. In order to dust the mechanism the breech was surrounded by a wooden box, with a curtain in front, which was tied around the gun. On the box was a hopper containing about two-thirds of a cubic foot of very finely pulverized sand from the sand butt. The dust runs through a slot into a wooden pipe, to which is connected a pipe from the blacksmith-shop bellows, by which means the dust is blown with considerable pressure against the breech. Bellows pumped during 8 minutes; only about half of the dust used. On removing the box the breech was found thoroughly covered with dust, which had also penetrated all parts of the breech. The hands only were permitted to be used in cleaning off the dust at first, but when the breech was opened the gun sponge was used. The block could not be opened without disconnecting the extractor from it, which was done by using a wire to raise the vertical bolt near the hinge of the console from engagement in the extractor sector. It is a point of considerable advantage to be able to do this, for otherwise it would have taken much longer to open the block. The block was dismounted from the console and dust brushed off. The chamber and bore were wiped out with the gun sponge and the same was used to brush the dust out of the breech threads and extractor rest, no oil or water being used. Time to open block and fire 5 rounds, 41 minutes 44 seconds.

Record of firing with Schneider 4.72-inch rapid-fire gun at Sandy Hook Proving

[Object of firing, test

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Instrumental velocity, 275 feet from muzzle.	Pressure per square inch of bore.	Pressure (French gauge).	Deflection, left.
		Kind.	Weight.	Kind.	Weight.					
			Lbs. Oz.		*Lbs. Oz.*	° '	*Feet.*	*Pounds.*	*Atmospheres.*	*Points.*
1894. Dec. 21	56	French smokeless, B. N.	18 8	....	48 8	....	....	....	....	....

[Object of firing, to test the gun for

1895. Jan. 2	57 to 67	French smokeless, B. N.	18 8	....	48 8	....	....	....	....	....

[Object of firing,

1895. Jan. 2	68	....	18 8	....	48 8	....	....	....	....	....

Ground, from November 19, 1894, to January 4, 1895—Continued.

of defective cartridge.]

Recoil.	Counter recoil.	Wind, strength, and direction.	General remarks.
Inches.	*Inches.*		
......	......	....	Mechanism thoroughly cleaned and oiled before this round. The cartridge case was prepared by filing 4 slots obliquely through the edge of the rim at an angle of about 40° with the axis so as just to touch the cavity of the cartridge case. The slots are at the extremities of 2 diameters at right angles with each other. Cartridge placed in the gun so that the solid part of the rim came opposite the extractor. Much gas escaped through the block and was blown fully 100 feet to the rear. The console latch was unlatched and the block had rotated slightly. Block could not be opened by hand and required blows on lever by a mallet to rotate it. When fully rotated the block was withdrawn by pounding from the muzzle with a rammer. The portion of the extractor which engages the rim of the cartridge was found broken off at the horizontal part. The fracture was covered with brass, showing that it had been broken by the escaping gases. The holes in the bottom of the slots of cartridge case were increased to about ¼ inch diameter; there was a wedge-shaped imprint of each slot covered with brass on the face of the breechblock. There were no spare extractors and the firing was suspended to repair this one.

accuracy with rapidity at 1 mile.]

Recoil.	Counter recoil.	Wind, strength, and direction.	Special remarks.	General remarks.
......	......	Wind right and rear, 25°, 11 miles an hour; barometer, 30.41; thermometer, 29°; humidity, 67.	Round 57: Sighting shot; struck target 1 foot 10 inches above and 4½ feet right of center.	Aimed at the upper left-hand corner. A new extractor was made to replace the one broken in previous firing.

SPECIAL REMARKS.

TARGET.

No. of round.	From center of target.				From center of impact.			
	Vertical.		Horizontal.		Vertical.		Horizontal.	
	Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.
58	.....	2	0.5	.....	1.325	.....	.....	5.3
59	.....	4.75	3.5	.....	.....	1.425	.....	2.3
60	.....	5	5.5	.....	.....	1.675	.....	0.3
61	.....	9.5	9	.....	.....	6.175	3.2	.....
62	.....	3	8.5	.....	0.325	.....	2.7	.....
63	.....	2	4.5	.....	1.325	.....	.....	1.3
64	.....	1.5	6.5	.....	1.825	.....	0.7	.....
65	.....	1.25	8.25	.....	2.075	.....	2.45	.....
66	.....	1.75	7	.....	1.575	.....	1.2	.....
67	.....	2.5	4.75	.....	.825	.....	.....	1.05

GENERAL REMARKS.

	Feet.
Center of impact:	
Below	3.325
Right	5.8
Mean vertical deviation from center of impact	1.855
Mean horizontal deviation from center of impact	2.05
Mean deviation from center of impact	2.765

Time to fire 10 rounds, 4 minutes 8 seconds.

blowback test.]

Recoil.	Counter recoil.	Wind, strength, and direction.	Special remarks.	General remarks.
......	......	....	....	The blowback was secured by thinning the metal of the primer. The firing pin was blown out and the spring bent and twisted.

Record of firing with Schneider 4.72-inch rapid-fire gun at Sandy Hook Proving

[Object of firing,

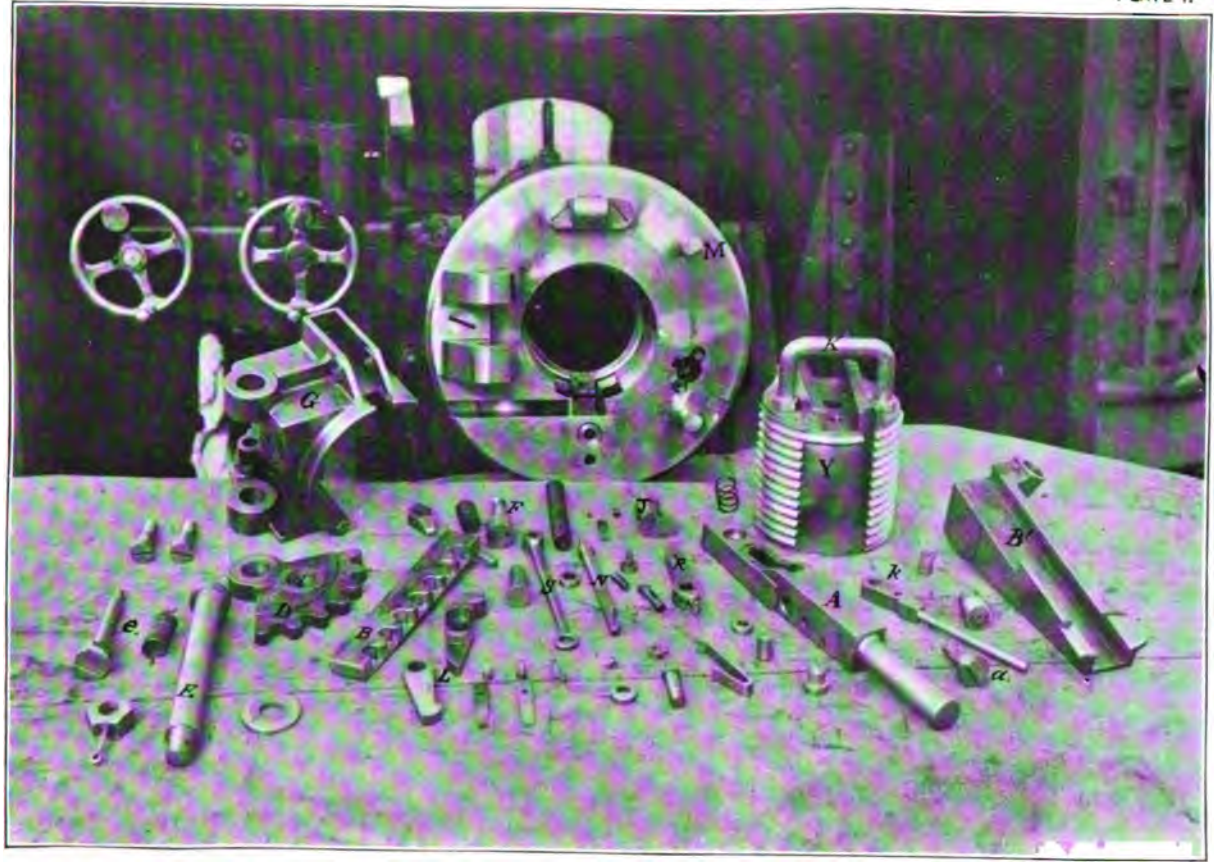
Date.	No. of fire.	Powder.			Projectile.			Elevation.	Instrumental velocity, 275 feet from muzzle.	Pressure per square inch of bore.	Pressure (French gauge).	Deflection, left.
		Kind.	Weight.		Kind.	Weight.						
			Lbs.	*Oz.*		*Lbs.*	*Oz.*	° ′	*Feet.*	*Pounds.*	*Atmospheres.*	*Points.*
1895. Jan. 4	69	Du Pont's sphero-hexagonal, U. F.; lot 3, ½-ounce igniter.	12	0	....	....		....	....	15, 21,848	....	....
Jan. 4	70		17	0	....	....		....	....	15, 50,286	....	....
Jan. 4	71		15	0	....	....		....	....	32,139	....	....
Jan. 4	72		16	0	....	....		....	....	10, 28,509	....	....
Jan. 4	73		16	0	....	....		....	....	10, 53,489	....	....
Jan. 4	74		15	0	....	....		....	....	10, 42,100	....	....

Ground, from November 19, 1894, to January 4, 1895—Continued.

excessive pressures.]

Recoil.	Counter recoil.	Wind, strength, and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Inches.	*Inches.*			
......	......	Wind from rear, 18 miles an hour; barometer, 30.24; thermometer, 33°; humidity, 71.	Uncompressed coppers of 1890	A new firing pin and spring. Firing conducted in the presence of the Ordnance Board. Colden L'H. Ruggles, Lieutenant, Ordnance Department, U. S. A. For the Board: Frank H. Phipps, Major, Ordnance Department, U. S. A.
......	......		24,000 coppers of 1890	
......	......		32,000 coppers of 1890	
......	......		28,000 coppers of 1890	
......	......		28,000 coppers of 1890	
......	......		24,000 coppers of 1890	

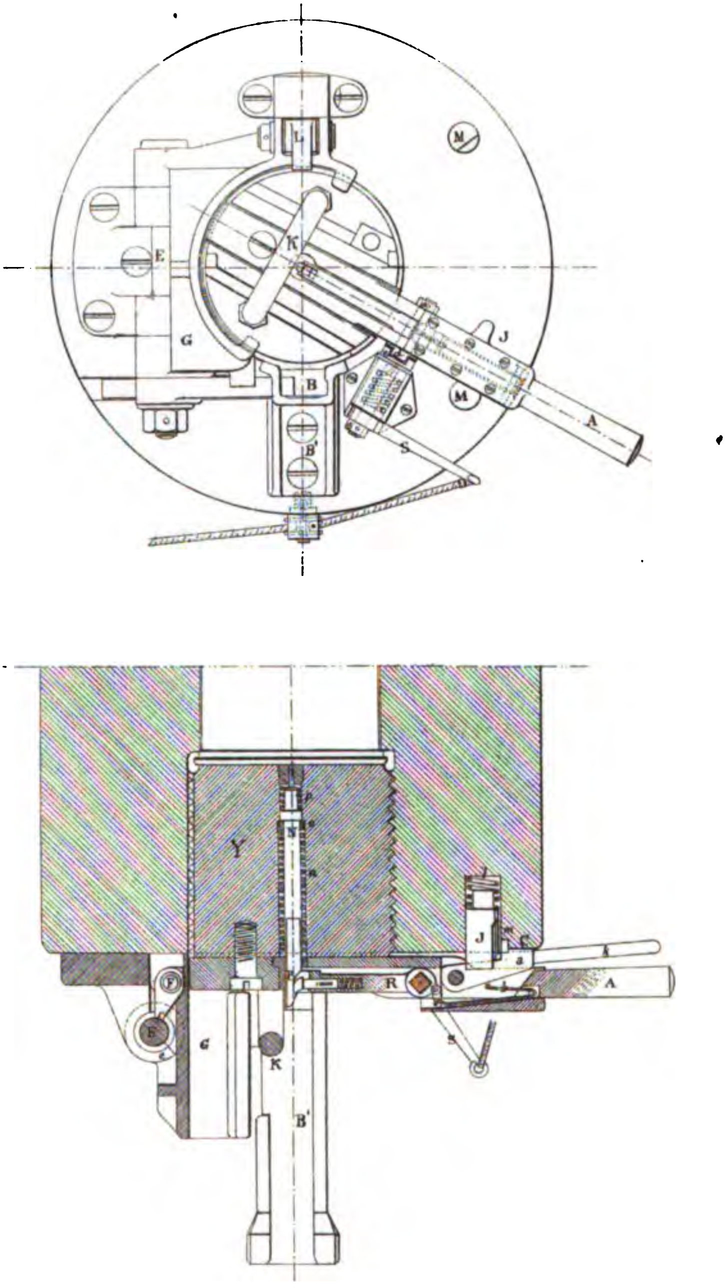
PLATE I.



PARTS OF BREECH MECHANISM. SCHNEIDER 4.7-INCH R. F. GUN.

Appendix 26, 1896.

Plate II.



Appendix 26, 1896.

BREECH MECHANISM-SCHNEIDER 4".7 RAPID FIRE GUN.

Ord 54 2

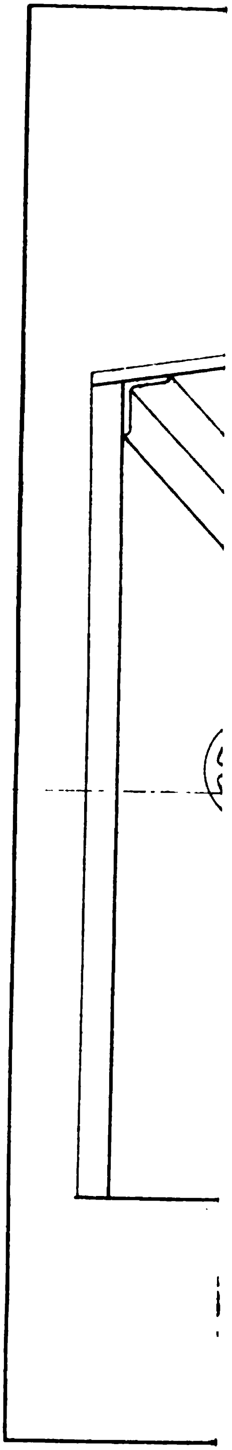
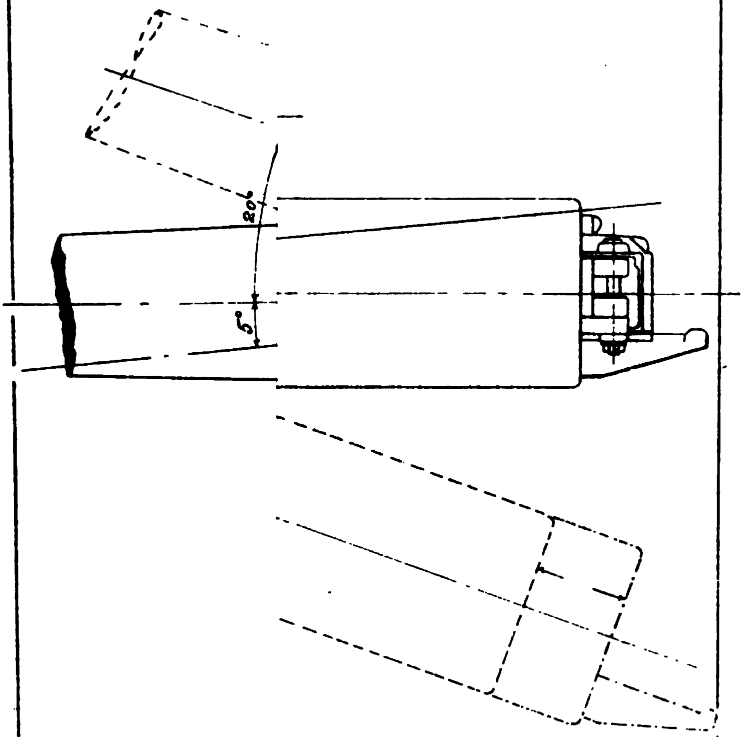


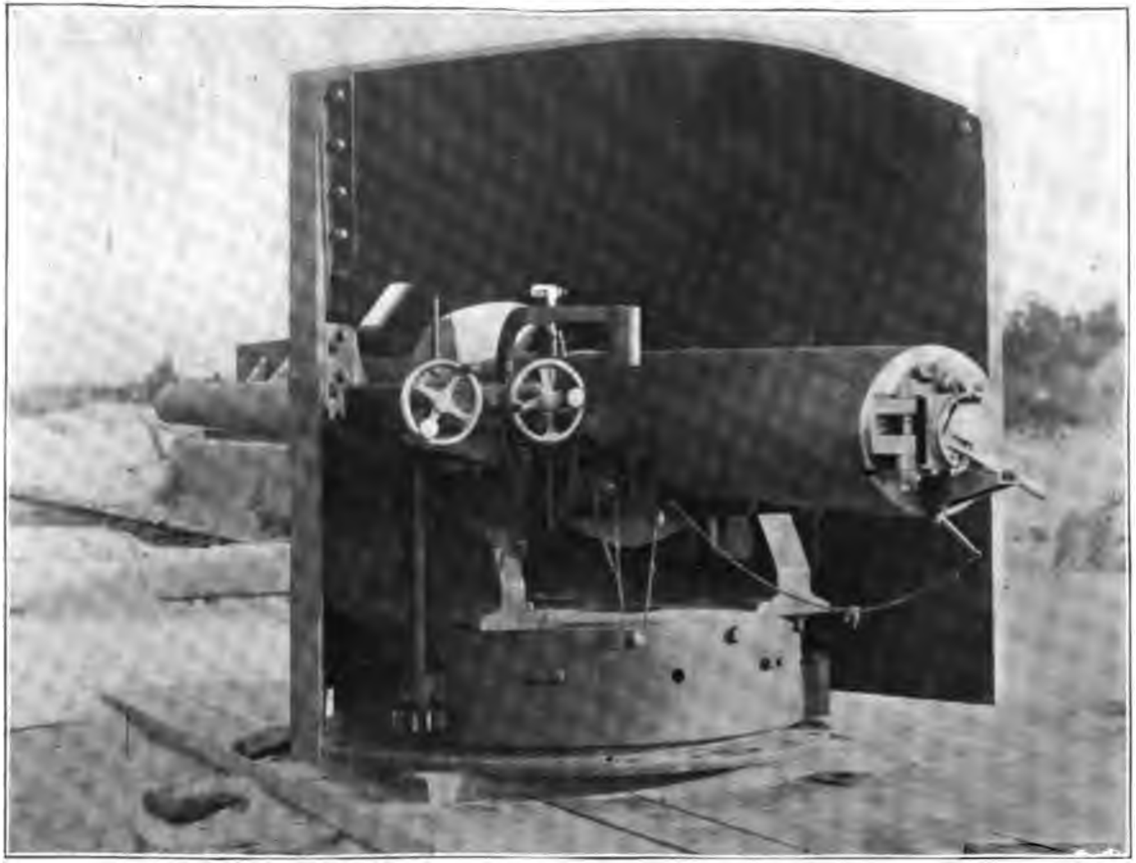
Plate V.



Appendix 26, 1896.

Ord 54 2

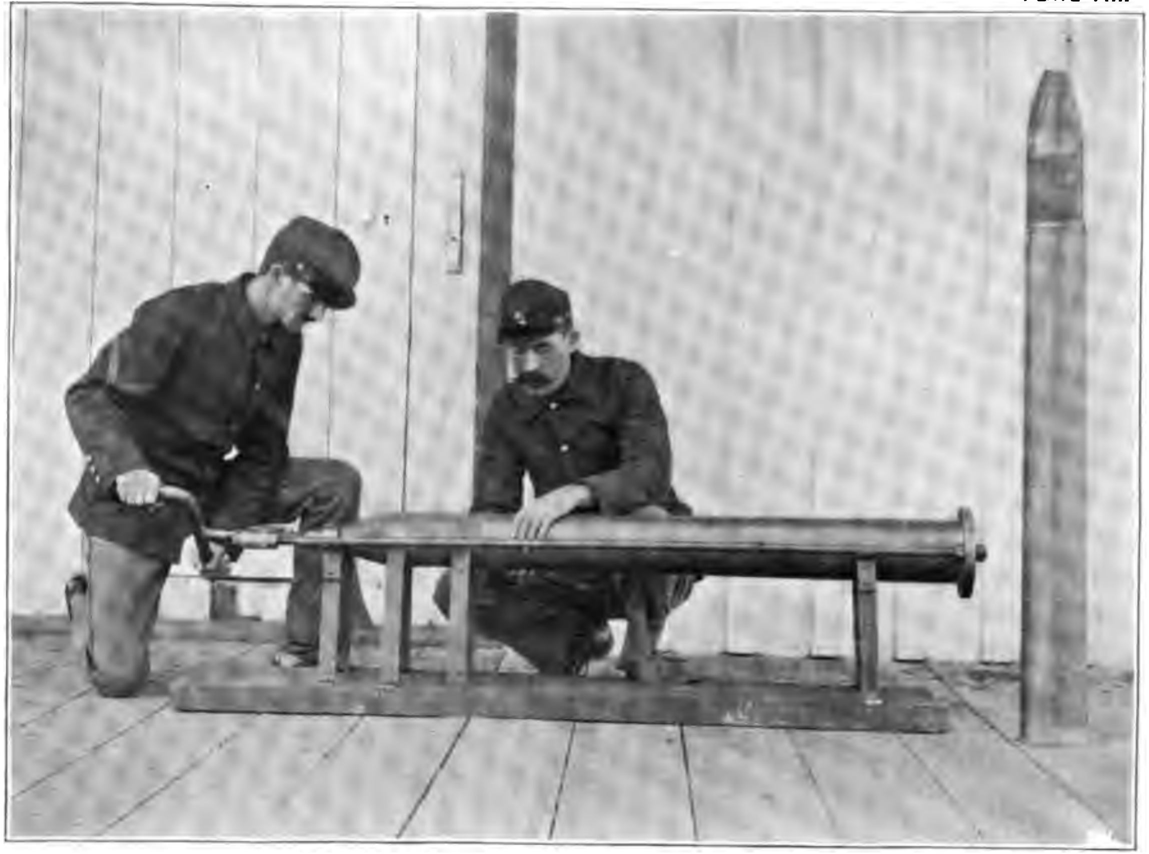
PLATE VII.



Appendix 26, 1896.

SCHNEIDER 4.7-INCH R. F. GUN AND MOUNT.

PLATE VIII.



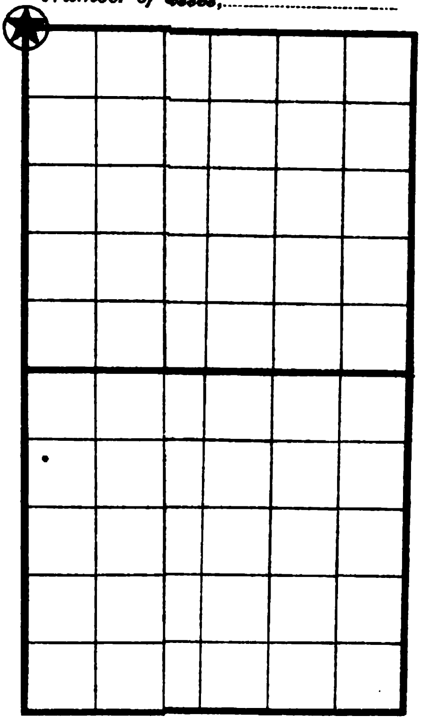
Appendix 26, 1898.

LOADING APPARATUS, AND FIXED AMMUNITION. SCHNEIDER 4.7-INCH R. F. GUN.

Plate IX

N. J. Dec 18th 189

Number of Shots,



Center o 73 feet

338.6

Point ai

'0'

Appendix 26, 1896.

Ord 54 2

N. J. Dec 18th 189

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S. H. Ruggles

LIEUT. ORDNANCE DEPT. U.S.A.

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Plate X.

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Appendix 26, 1896.

Ord 54 2

APPENDIX 27.

PROGRESS REPORT ON TRIAL OF CROZIER 10-INCH WIRE-WOUND B. L. RIFLE.

(6 plates.)

THE ORDNANCE BOARD, U. S. A.,
NEW YORK ARSENAL,
GOVERNORS ISLAND, NEW YORK HARBOR,
New York City, January 11, 1896.

SIR: The following report of the test of a 10-inch Crozier wire-wound breech-loading rifle, made in accordance with instructions contained in the first indorsement on Ordnance Office file 3710 of 1894, is respectfully submitted:

Description and drawings of the gun are on file in the Ordnance Department.

A progress report of the test of the gun was submitted on November 1, 1894, after 77 rounds had been fired from it, but is included in the present report, which covers the test from the beginning.

The following rounds have been fired:

Charge.	Number of rounds.	Charge.	Number of rounds.	Charge.	Number of rounds.	Charge.	Number of rounds.
Pounds.		*Pounds.*		*Pounds.*		*Pounds.*	
80	1	240	56	266	3	288	63
150	2	242	4	267	1	290	65
160	2	245	5	268	4	293	4
180	2	250	1	270	1		
200	2	253	1	273	14		275
225	2	254	1	278	1		
230	1	255	2	279	32		
238	2	258	2	280	1		

Of the above rounds, 20 gave pressures below 35,000 pounds per square inch, 14 between 35,000 and 40,000, 231 between 40,000 and 45,000, and 10 over 45,000 pounds. The maximum pressure was 46,000 pounds. The designed pressure is 42,000 pounds per square inch. The maximum velocity attained was 2,123 feet per second with a charge of 290 pounds of Du Pont's brown prismatic X. B. powder, giving a pressure of 41,500 pounds per square inch. The designed velocity is 2,100 feet per second.

Targets have been made as follows:

After 94 rounds, of 10 shots at 3,000 yards, with 3.04 feet mean deviation.
After 107 rounds, of 10 shots at 1 mile, with 1.8 feet mean deviation.
After 128 rounds, of 10 shots at 1 mile, with 4.64 feet mean deviation.
After 189 rounds, of 8 shots at 1 mile, with 1.89 feet mean deviation.
After 189 rounds, of 8 shots at 1 mile, with 2.29 feet mean deviation.
After 270 rounds, of 5 shots at 1 mile, with 1.95 feet mean deviation.

In making the first and second of the above targets, the gun was pointed by means of marks on the carriage; in making the third and fourth, a Scott telescopic sight was used on the trunnion of the gun; with the fifth and sixth, again marks upon the carriage. The fourth and fifth were of alternate shots so as to insure identity of conditions. Plots of the targets are inclosed.

Star-gauge measurements were made after 67, 117, 188, and 275 rounds. The total enlargement of the chamber along its middle length runs from 0.007 to 0.015 inch. The star-gauging record is inclosed.

The breech mechanism is of service type except for slight increase in the size of the block.

A test for rapidity of fire made with the gun mounted upon the 10-inch experimental Buffington-Crozier disappearing carriage resulted in 10 rounds being fired in 14 minutes 42 seconds.

The gun is now so eroded at the commencement of the rifling that, being experimental for other purposes than the effect of erosion, it is not considered judicious to subject it to further firing without lining, unless it be considered that the test for efficiency and stability of the system of construction is at an end, and it is desired to gain knowledge as to the extent to which erosion can be allowed to proceed without danger. The accuracy of the piece, provided projectile bands of increased diameter be used, does not seem to be impaired. Relining is permitted for guns built under contract for the Department after 250 rounds. Impressions of the eroded portion of the bore are forwarded.

The strength and endurance of the system seem to have been abundantly proven by this test. The design does not indicate as great transverse stiffness of chase as that of the service guns if it be assumed that the wire affords no assistance in this particular; the results of the test, however, indicate that such an assumption would be erroneous, since, after a careful examination of the gun, no evidence whatever can be found of a lack of stiffness at any part of the bore. If special attention were given to this feature it is probable that a still greater stiffness could be given to the chase without materially changing the design.

No superiority of theoretical transverse strength over that of the service type of gun is claimed by the inventor for this system.

The designed powder pressure is placed 5,000 pounds per square inch higher than for the service type for reasons which he states about as follows: In the service gun the elastic limit of the exterior cylinders is reached when that of the tube is; any higher pressure, overstraining the tube, will therefore also overstrain the outer parts, which thenceforth will cease to afford the designed support to the tube. In the wire gun the large reserve of strength of the tube's envelope prevents this condition from arising. Nearly the maximum theoretical strength can therefore be utilized with confidence.

Further alleged advantage is based upon cheapness of construction.

The following is a comparison of certain elements of this gun and the 10-inch service gun as shown by the tests of the Crozier and the type 10-inch, as far as they have proceeded, that of the type gun being still in progress:

	Service.	Crozier.
Weight ....tons..	30	30
Projectile ....pounds..	575	575
Charge ....do....	250	267
Pressure per square inch....do....	37,000	42,000
Velocity....feet per second..	1,975	2,100
Muzzle energy....foot-tons..	15,550	17,560
Rounds fired:		
Brown powder....number..	260	275
Smokeless powder ....do....	8	....
Mean charge:		
Brown powder ....pounds..	220	267
Smokeless powder....do....	115	....
Mean pressure per square inch....do....	32,800	40,800
Maximum pressure per square inch..do....	61,000	46,000
Enlargement along middle length of chamber....inches..	[a] 0.003 to 0.005	0.007 to 0.015

[a] After 244 rounds.

It is proper to state that the type gun is not so badly eroded as the Crozier and it is still in condition to be fired.

FRANK H. PHIPPS,
Major, Ordnance Department, U. S. A., President.
FRANK HEATH,
Captain, Ordnance Department, U. S. A.
J. C. AYRES,
Captain, Ordnance Department, U. S. A.

The CHIEF OF ORDNANCE, UNITED STATES ARMY,
Washington, D. C.

NOTE.—By authority of the Chief of Ordnance, Captain Crozier was, at his own request, relieved from duty with the Board in rendering the above report.

(3710)

[NOTE.—For rounds Nos. 1 to 68 of this firing, see

Record of firing with 10-inch B. L. rifle, Crozier wire-wound (weight, 67,300 pounds), Water-

[Object of fir-

Date.	No. of fire.	Powder.			Projectile.		Shot stamped.	Travel of shot in bore.	Elevation.	Instrumental velocity (feet).	Pressure per square inch of bore.
		Kind.	Weight.	No. of prisms.	Kind.	Weight.					
1894.			*Lbs. Oz.*			*Lbs. Oz.*		*Inches.*	° ′	*275 feet from muzzle.*	*Pounds.*
Oct. 5	69	Du Pont's brown prismatic, W. H., lot 4.	122 13½ 121 13½ 5 245 0	1,300 1,288 Igniter.	Shot rebanded.	571 0	....	275.2	10 0	....	Q, 37,120 U, 38,200
Oct. 5	70		122 13½ 121 13½ 5 245 0	1,300 1,288 Igniter.	Shot, lot 537.	574 0	....	275.1	10 0	....	Q, 37,860 U, 38,077
Oct. 9	71		124 13½ 124 13½ 5 250 0	1,321 1,322 Igniter.	Shot rebanded.	575 0	....	275.1	−1 45½	1,959 1,992	Q, 38,000 U, 38,945
Oct. 9	72		129 13½ 124 13½ 5 255 0	1,374 1,321 Igniter.		575 0	....	275.1	−1 45½	1,997 2,014 200+1½°	Q, 38,600 U, 39,520
Oct. 12	73	Du Pont's brown prismatic, V. U. lot 15.	121 13½ 117 13½ 5 240 0	1,305 1,258 Igniter.	Solid shot, lot 537.	570 8	....	Not taken.	10 0	....	J, 36,080 O, 36,400
Oct. 12	74		121 13½ 117 13½ 5 240 0	1,279 1,264 Igniter.		575 0	....		10 0	....	J, 35,894 O, 35,800
Oct. 12	75		119 13½ 119 13½ 5 240 0	1,286 1,288 Igniter.		575 0	....		10 0	....	J, 37,260 O, 36,244
Oct. 12	76	Du Pont's brown prismatic, V. U., lot 17.	119 13½ 119 13½ 5 240 0	1,286 1,288 Igniter.		575 0	....		10 0	....	J, 32,062 O, 32,345
Oct. 23	77		119 13½ 119 13½ 5 240 0	1,248 1,274 Igniter.		575 0	....		10 0	....	Y, 32,900

Report of Chief of Ordnance for 1894, pages 312 to 337.]

vliet Arsenal, at Sandy Hook Proving Ground, from October 5, 1894, to February 18, 1895.

ing, test of gun.]

Notch pawl engaged in.	Recoil.	Wind, strength, and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
	Ft. In.			
20		Wind from right and rear, 45°, 10 miles an hour; barometer, 29.85; thermometer, 66°; humidity, 53.		Gun mounted on Buffington-Crozier disappearing carriage. Obturating friction primers. Fired to sea, rounds 69 and 70, and into sand butt No. 1, rounds 71 and 72. Counterweight 66,787 pounds. 32,000 coppers of 1892. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer, in the presence of the Ordnance Board. Present: Maj. F. H. Phipps, Ordnance Department; Capt. F. Heath, Ordnance Department; Capt. W. Crozier, Ordnance Department.
17			3 gallons of oil added to cylinders before this round.	
20			2½ gallons of oil added to cylinders	
30				
14				Gun mounted on Buffington-Crozier disappearing carriage. Obturating friction primers. Fired to sea. 32,000 coppers of 1892. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, in the presence of the Board on Disappearing Carriages. Present: Col. F. H. Parker, Ordnance Department; Maj. C. E. L. B. Davis, Corps Engineers; Maj. H. C. Hasbrouck, Fourth Artillery.
15				
16				
17				
13				

Record of firing with 10-inch B. L. rifle, Crozier wire-wound (weight, 67,300

[Object of firing,

Date.	No. of fire.	Powder.			Projectile.		Shot stamped.	Travel of shot in bore.	Depression.	Instrumental velocity (feet).	Pressure per square inch of bore.
		Kind.	Weight.	No. of prisms.	Kind.	Weight.					
			Lbs. Oz.			*Lbs. Oz.*		*Inches.*	° ′	*275 feet from muzzle.*	*Pounds.*
1895. Jan. 8	78	Du Pont's brown prismatic, X. A., received Jan. 3, 1895.	111 13½ 112 13½ 5 225 0	1,158 1,167 Igniter.	Solid shot, lot 537.	577 0	....	275.170	1 36	1,885 1,899	U, 32,833 V, 30,800
Jan. 8	79		129 13½ 124 13½ 5 255 0	1,344 1,291 Igniter.		578 0	....	275.270	1 36	Lost. 2,023	U, 38,500 V, 39,210
Jan. 9	80		129 13½ 135 13½ 5 266 0	1,341 1,402 Igniter.		577 0	....	275.270	1 36	2,054 2,067	U, 40,960 V, 42,855
Jan. 9	81		134 13½ 130 13½ 5 266 0	1,396 1,354 Igniter.		577 0	....	274.970	1 36	2,079 2,079	U, 40,923 V, 43,455

pounds), Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

to prove powder.]

Notch pawl engaged in.	Recoil.	Wind, strength, and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
	Ft. In.			
......	5 8	Wind from left and rear, 45°; barometer, 30.35; thermometer, 35°; humidity, 92.	18¼ gallons of oil added to the cylinder and reservoir before firing; 24 pigs of lead (2,328 pounds) on counterweight. Gun raised in battery with the valve pointer at the small dot, about ⅛ inch below the arrow. The cap of the left buffer was found broken off before firing; it was put in place without fastening. The well for the counterweight contained considerable water, which came nearly to the top of the counterweight when the latter was down. The gun failed to run in battery by 1 inch and was fired in this position. The left retaining pawl engaged in the twelfth tooth of the ratchet. The right spring cap for retaining pawl stuck in its seat by a slight upsetting of metal object around it and the pawl did not engage. The elevating gear wheel jumped 2⅞ inches past the pointer on firing in the direction to depress the muzzle. The nut on the spring of the friction clamp was screwed down one thread before next round.	Gun mounted on Buffington-Crozier disappearing carriage. Fired into butt No. 2. Since last firing the elevating gear has been repaired and improved by increasing the size of the keys holding the pinions to their shafts and relieving the pressure on the friction clamp, thus permitting a slight motion to the elevating wheel and intermediate gear from the jump of the gun. Neutral oil in cylinder; weight, 52.5 pounds per cubic foot. Round 78: 24,000 coppers of 1890; 18,000 coppers of 1892. Round 79: 32,000 coppers of 1890. Round 80: 32,000 coppers of 1890. Round 81: 32,000 coppers of 1890; 40,000 coppers of 1893.
......	5 8		The gun ran well into battery for this round, with the same throttling as before. Before firing an iron weight was arranged to operate the right retaining pawl, but the string holding it broke on firing and the pawl failed to engage as before. Left pawl engaged in the last (thirteenth) notch. The left buffer cap was tied in place by wire, but fell off on firing. The right gun lever came to within about ⅛ inch of the buffer. The gear wheel jumped $3\frac{1}{16}$ inches. The nut on spring screwed down another thread.	
......	5 9	Wind from left and rear, 45°; barometer 30.55; thermometer, 33°; humidity, 80.	Before raising the gun the water in the well was pumped out and 5 pigs of lead (485 pounds) were added to the counterweight. For raising the gun the valve was throttled a little more, the pointer being about half as far below the small dot as the dot is below the arrow. Throttling good for 29 pigs. Before firing both buffers were taken off and new bolts were put through them, countersunk in the caps. The spring cap for the right retaining pawl was also repaired. The gun levers struck the buffers lightly. Elevating gear wheel jumped 3 inches. Pawl engaged in last notch.	
......	5 9		5 pigs of lead added to counterweight after raising the gun. The gun levers struck the buffers lightly. Elevating gear wheel jumped about 2 inches. Pawl engaged in last notch.	

Record of firing with 10-inch B. L. rifle, Crozier wire-wound (weight 67,800

[Object of firing,

Date.	No. of fire.	Powder.				Projectile.			Shot stamped.	Travel of shot in bore.	Elevation.	Instrumental velocity (feet).	Pressure per square inch of bore.
		Kind.		Weight.	No. of prisms.	Kind.	Weight.						
				Lbs. *Oz.*			*Lbs.*	*Oz.*		*Inches.*	° ′	*250 feet from muzzle.*	*Pounds.*
1895. Feb. 1	82	Du Pont's brown prismatic.	X. A., lot 2., received Jan. 31, 1895.	119 13½ 119 13½ 5 240 0	1,245 1,245 Igniter.	Solid shot, lot 537.	576	0	....	275.170	....	1,855 1,863	T, less than 28.000 V, less than 28,000
Feb. 1	83			128 13½ 128 13½ 5 258 0	1,338 1,337 Igniter.		576	0	10	275.070	....	1,934 1,934	J, 34,267 O, 29,969
Feb. 1	84			144 13½ 144 13½ 5 290 0	1,504 1,503 Igniter.		576	0	11	275.170	....	2,102 2,103	J, 43,280 O, 41,462
Feb. 2	85		X. B., received Jan. 31, 1895.	129 6¼ 128 13½ 5 258 9	1,348 1,340 Igniter.		576	0	12	275.170	....	1,968 1,959	J, 34,018 O, 34,400
Feb. 2	86			144 13½ 144 13½ 5 290 0	1,506 1,506 Igniter.		577	0	13	275.170	....	2,129 2,117	J, 40,969 O, 41,620
Feb. 2	87		X.A., lot 1.	132 13½ 132 13½ 5 266 0	1,376 1,374 Igniter.		575	0	14	275.170	......	2,103 2,086 175+1½°	J, 38,985 O, 38,527

pounds), Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

test of gun.]

Notch pawl engaged in.	Recoil.	Wind, strength, and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
	Ft. In.			
5	......	Wind from right and rear, 20°, 8 miles an hour; barometer, 30.49; thermometer, 31°; humidity, 69.	Gun let in battery with the valve pointer on arrow. Elevating gear wheel jumped 1½ inches. 28,000 coppers of 1890.	Gun mounted on Buffington-Crozier disappearing carriage. Neutral oil removed from cylinder, and 64½ gallons of zero oil put in. Fired into sand butt No. 2. Counterweight 67,003 pounds (24 pigs). Elevation given by marks on carriage. Before the firing of February 2 35 gallons of zero oil was removed from cylinders and 36 gallons of neutral oil added.
3	......		Gun raised 1 notch by hand and loaded in the sixth notch. Valve pointer just a little above arrow came within 17 inches of battery; valve opened and gun ran within 4 inches. Embarred the rest. Elevating gear wheel jumped 2½ inches. 24,000 coppers of 1890, gauge J; 28,000 coppers of 1890, gauge O.	
9	......		Gun loaded with the pawl engaged in the sixth notch. Pointer on arrow. One gallon of oil added to cylinder. Gun came within 4 inches of battery. Embarred to battery. Elevating gear wheel jumped 3½ inches. 32,000 coppers of 1890.	
9	......	Wind from right and rear, 15°, 12 miles an hour; barometer, 30.17; thermometer, 32°; humidity, 90.	Gun ran in battery with the valve pointer half way between the arrow and the dot. 32,000 coppers of 1890.	
14	......		32,000 coppers of 1890......................	
11	......		Fired to verify a lot of powder previously proved.	

Record of firing with 10-inch B. L. rifle, Crozier wire-wound (weight, 67,300

[Object of firing, to test gun

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Powder. No. of prisms.	Projectile. Kind.	Projectile. Weight.	Shot stamped.	Travel of shot in bore.	Elevation.	Instrumental velocity (feet).	Pressure per square inch of bore.
1895.			*Lbs. Oz.*			*Lbs. Oz.*		*Inches.*	° ′	*250 feet from muzzle.*	*Pounds.*
Feb. 15	88	Du Pont's brown prismatic, X. A., lot 1.	140 9½ 137 13½ 5 278 12	1,450 1,423 Igniter.	Solid shot, lot 537.	575 0	....	275.170	2 20	....	J, 41,980 O, 42,644
Feb. 15	89		140 9½ 137 13½ 5 278 12	1,449 1,424 Igniter.		575 0	....	275.170	2 15	....	J, 42,418 O, 42,800
Feb. 15	90		140 9½ 137 13½ 5 278 12	1,449 1,423 Igniter.		576 0	....	275.170	2 5	....	....
Feb. 15	91		140 9½ 137 13½ 5 278 12	1,450 1,421 Igniter.		577 0	....	275.170	2 2	....	....
Feb. 15	92		140 9½ 137 13½ 5 278 12	1,450 1,424 Igniter.		578 0	....	275.170	2 2	....	....
Feb. 15	93		140 9½ 137 13½ 5 278 12	1,449 1,424 Igniter.		576 0	....	275.170	10 0	....	....
Feb. 16	94		140 9½ 137 13½ 5 278 12	1,450 1,424 Igniter.		577 0	....	275.170	2 2	....	....
Feb. 16	95		140 9½ 137 13½ 5 278 12	1,450 1,424 Igniter.		576 0	....	275.170	1 58	....	....
Feb. 16	96		140 9½ 137 13½ 5 278 12	1,449 1,423 Igniter.		575 0	....	275.170	1 58	....	....
Feb. 16	97		140 9½ 137 13½ 5 278 12	1,449 1,424 Igniter.		575 0	....	275.170	1 58	....	....

pounds), Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

for accuracy at 3,000 yards.]

Notch pawl engaged in.	Recoil.	Wind, strength, and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
	Ft. In.			
14	......	Wind from right and rear, 40°, 6 miles an hour; barometer, 30.46; thermometer, 35°; humidity, 72.	Struck 310 yards in rear and 10 feet to the left of center of target. 32,000 coppers of 1890.	Gun mounted on Buffington-Crozier disappearing carriage. Obturating friction primers. Counterweight, 67,003 pounds. Fired at 3,000-yard target. Before this firing 10 gallons of zero oil removed and 12 gallons of neutral oil added to cylinders. Aimed by marks made on the carriage. Valve pointer half way between the arrow and the dot.
14	......		Struck 300 yards in rear and 10 feet to the left of center. 32,000 coppers of 1890.	
14	......		Struck target 10½ feet above, 4½ feet right of center. Nuts on spindle tightened.	
15	......		Struck target 2 feet 4 inches above and 1 foot right of center.	
15	......		Struck target 4 feet above and 1 foot left of center.	
11	......		Fired to sea......	

TARGET.

Notch pawl engaged in.	Recoil.	Wind, strength, and direction.	From center of target. Vertical. Above.	From center of target. Vertical. Below.	From center of target. Horizontal. Right.	From center of target. Horizontal. Left.	From center of impact. Vertical. Above.	From center of impact. Vertical. Below.	From center of impact. Horizontal. Right.	From center of impact. Horizontal. Left.	General remarks.
11	......	Wind from right and rear, 15°, 4 miles an hour; barometer, 30.10; thermometer, 35°; humidity, 72.	......	......	......	......	......	......	......	......	Gun mounted on Buffington-Crozier disappearing carriage. Obturating friction primers. Fired at 3,000-yard target. Elevation given by marks made on elevating gear wheel, and direction given by marks made on traverse circle. Counterweight, 67,003 pounds. Round 97: This shot considered unreliable, and not counted in target. Struck target 8 feet 4 inches above and 10 feet right.
			Feet.	*Ft.*	*Feet.*	*Ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
13	......		5	....	4.25	....	3.5	.....	2.025	......	
14	......		3	....	3	....	1.5	.....	0.775	......	
18	......		......	......	......	......	......	......	......	......	

Record of firing with 10-inch B. L. rifle, Crozier wire-wound (weight, 67,300

[Object of firing, to test gun

Date.	No. of fire.	Powder.			Projectile.		Shot stamped.	Travel of shot in bore.	Elevation.	Instrumental velocity (feet).	Pressure per square inch of bore.
		Kind.	Weight.	No. of prisms.	Kind.	Weight.					
			Lbs. Oz.			*Lbs. Oz.*		*Inches.*	° ′	*250 feet from muzzle.*	*Pounds.*
1895. Feb. 16	98	Du Pont's brown prismatic, X. A., lot 1.	140 9⅛ 137 13⅞ 5 278 12	1,449 1,423 Igniter.	Solid shot, lot 537.	576 0	....	275.170	1 58	....	....
Feb. 16	99		140 9⅛ 137 13⅞ 5 278 12	1,451 1,424 Igniter.		575 0	....	275.170	1 58	....	....
Feb. 16	100		140 9⅛ 137 13⅞ 5 278 12	1,449 1,423 Igniter.		575 0	....	275.170	1 58	....	....
Feb. 16	101		140 9⅛ 137 13⅞ 5 278 12	1,449 1,422 Igniter.		577 0	....	275.170	1 58	....	....
Feb. 16	102		140 9⅛ 137 13⅞ 5 278 12	1,449 1,422 Igniter.		576 0	....	275.170	1 58	....	....
Feb. 16	103		140 9⅛ 137 13⅞ 5 278 12	1,450 1,423 Igniter.		575 0	....	275.170	1 58	....	....
Feb. 16	104		140 9⅛ 137 13⅞ 5 278 12	1,451 1,423 Igniter.		576 0	....	275.170	1 58	....	....
Feb. 16	105		140 9⅛ 137 13⅞ 5 278 12	1,453 1,423 Igniter.		576 0	....	275.170	1 58	....	....

pounds), Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

for accuracy at 3,000 yards.]

Notch pawl engaged in.	Recoil.	Wind, strength, and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.								General remarks.
			TARGET.								
			From center of target.				From center of impact.				
			Vertical.		Horizontal.		Vertical.		Horizontal.		
			Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.	
	Ft. In.		Feet.	Ft.	Feet.	Ft.	Feet.	Feet.	Feet.	Feet.	
14	....	Wind from right and rear, 15°, 4 miles an hour; barometer, 30.10; thermometer, 35°; humidity, 72.	2.5	....	6.5	....	1	.....	4.275	......	Gun mounted on Buffington-Crozier disappearing carriage. Obturating friction primers. Fired at 3,000-yard target. Elevation given by marks made on elevating gear wheel, and direction given by marks made on traverse circle. Counterweight, 67,003 pounds.
14	....		1	....	3.5	....	.....	0.5	1.275	......	
14	....		1.5	....	6.5	....	0		4.275	......	
14	....		2.5	....	.....	2	1	.....	.....	4.225	
14	....		.....	2.5	2	....	.....	4	......	0.225	
14	....		1.5	....	.....	1.5	0		......	3.725	
15	....		.....	2.5	.....	1	.....	4	......	3.225	
15	....		3	....	1	....	1.5	.....	......	1.225	

Center of impact:	Feet.
Above	1.5
Right	2.225
Mean vertical deviation from center of impact	1.7
Mean horizontal deviation from center of impact	2.525
Mean deviation from center of impact	3.04

Record of firing with 10-inch B. L. rifle, Crozier wire-wound (weight, 67,300

[Object of firing, to test

Date.	No. of fire.	Powder.			Projectile.		Shot stamped.	Travel of shot in bore.	Elevation.	Instrumental velocity. (feet).	Pressure per square inch of bore.
		Kind.	Weight.	No. of prisms.	Kind.	Weight.					
1895.			*Lbs. Oz.*			*Lbs. Oz.*		*Inches.*	*Quad.* ° '	*250 feet from muzzle.*	*Pounds.*
Feb. 18	106	Du Pont's brown prismatic, X. A., lot 1.	140 9½ 137 13½ 5 278 12	1,451 1,423 Igniter.	Solid shot, lot 537.	575 0	....	275.170	1 0	....	J, 44,650 O, 42,689
Feb. 18	107		140 9½ 137 13½ 5 278 12	1,450 1,424 Igniter.		575 0	....	275.170	0 54	....	J, 44,220 O, 44,422
Feb. 18	108		140 9½ 137 13½ 5 278 12	1,449 1,423 Igniter.		576 0	....	275.170	0 54	....	J, 43,489 O, 44,000
Feb. 18	109		140 9½ 137 13½ 5 278 12	1,450 1,422 Igniter.		575 0	....	275.170	0 54	....	J, 45,244 O, 45,022
Feb. 18	110		140 9½ 137 13½ 5 278 12	1,450 1,423 Igniter.		576 0	....	275.170	0 54	....	....
Feb. 18	111		140 9½ 137 13½ 5 278 12	1,450 1,426 Igniter.		576 0	....	275.170	0 54	....	....
Feb. 18	112		140 9½ 137 13½ 5 278 12	1,451 1,423 Igniter.		576 0	....	275.170	0 54	....	....
Feb. 18	113		140 9½ 137 13½ 5 278 12	1,450 1,424 Igniter.		575 0	....	275.170	0 54	....	....
Feb. 18	114		140 9½ 137 13½ 5 278 12	1,451 1.424 Igniter.		575 0	....	275.170	0 54	....	....
Feb. 18	115		140 9½ 137 13½ 5 278 12	1,451 1.423 Igniter.		575 0	....	275.170	0 54	....	....
Feb. 18	116		140 9½ 137 13½ 5 278 12	1,450 1,423 Igniter.		576 0	....	275.170	0 54	....	....
Feb. 18	117		140 9½ 137 13½ 5 278 12	1,451 1,424 Igniter.		577 0	....	275.170	0 54	....	....

pounds), *Watervliet Arsenal, at Sandy Hook Proving Ground, etc.*—Continued.

accuracy of gun at 1 mile.]

Notch pawl engaged in.	Recoil.	Wind, strength, and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	TARGET. From center of target. Vertical. Above.	Below.	Horizontal. Right.	Left.	From center of impact. Vertical. Above.	Below.	Horizontal. Right.	Left.	General remarks.
	Ft. In.			*Feet.*	*Ft.*	*Feet.*	*Ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
15	....	Wind from right and front, 10°, 8 miles an hour; barometer, 30.04; thermometer, 41°; humidity, 60.	Struck target 12 feet above, 8½ feet left...									
15	....		Nuts on spindle tightened. Struck target 0.5 foot below, 14 feet right.									
15	....			.....	2	5	....	0.65	.....	0.075	......	Obturating friction primers. Counterweight, 67,003 pounds. Fired at 1-mile target. Aimed by marks made on the carriage. 32,000 coppers of 1890. Center of impact: Feet. Below .... 2.65 Right .... 4.925 Mean vertical deviation from center of impact. 1.38 Mean horizontal deviation from center of impact .... 1.155 Mean deviation from center of impact ...... 1.8 Firing conducted by Lieut. F. P. Peck, Ordnance Department, in the presence of the Ordnance Board. Present: Maj. F. H. Phipps, Ordnance Department; Capt. F. Heath, Ordnance Department; Capt. W. Crozier, Ordnance Department.
15	....			.....	2	7.5	....	0.65	.....	2.575	......	
15	....			.....	2.5	5	....	0.15	.....	0.075	......	
16	....			.....	0.5	3	....	2.15	.....	......	1.925	
16	....			.....	0	6	....	2.65	.....	1.075	......	
16	....			.....	2	6	....	0.65	.....	1.075	......	
16	....			.....	3	3	....	.....	0.35	......	1.925	
16	....			.....	5	5	....	.....	2.35	0.075	......	
16	....			.....	3	3	....	.....	0.35	......	1.925	
16	....			.....	6.5	5.75	....	.....	3.85	0.825	.....	

Record of firing with 10-inch B. L. rifle, Crozier wire-wound (weight, 67,300 pounds)

[Object of firing, to test gun

Date	No. of fire.	Powder.				Projectile.			Elevation, quadrant.	Pressure per square inch of bore.	Deflection points, right.	Notch pawl engaged in.
		Kind.	Weight.		No. of prisms.	Kind.	Weight.					
			Lbs.	*Oz.*			*Lbs.*	*Oz.*	′	*Pounds.*		
1895.												
Feb. 27	118	Du Pont's brown prismatic, X. A., lot 1.	140 137 278	9½ 13½ 5 12	1,450 1,426 Igniter.	Solid shot, lot 537.	575	0	54	J, 43,800 O, 45,280	9	16
Feb. 27	119		137 134 273	13½ 13½ 5 0	1,426 1,391 Igniter.		575	0	....	J, 42,500 O, 44,460	4	16
Feb. 27	120		137 134 273	13½ 13½ 5 0	1,424 1,390 Igniter.		577	0	....	J, 43,444 O, 44,660	2	16
Feb. 27	121		137 134 273	13½ 13½ 5 0	1,424 1,394 Igniter.		577	0	....	J, 44,200 O, 45,200	2	16
Feb. 27	122		137 134 273	13½ 13½ 5 0	1,422 1,392 Igniter.		577	0	....	J, 38,700 O, 46,100	2	15
Feb. 27	123		137 134 273	13½ 13½ 5 0	1,423 1,392 Igniter.		577	0	....	J, 42,600 O, 44,100	2	16
Feb. 27	124		137 134 273	13½ 13½ 5 0	1,426 1,391 Igniter.		577	0	....	J, 43,800 O, 46,600	2	17
Feb. 27	125		137 134 273	13½ 13½ 5 0	1,422 1,392 Igniter.		577	0	....	J, 43,340 O, 43,866	2	18
Feb. 28	126		134 132 268	13½ 13½ 5 0	1,392 1,370 Igniter.		575	0	....	J, 40,289 O, 42,289	2	17
Feb. 28	127		134 132 268	13½ 13½ 5 0	1,393 1,373 Igniter.		575	0	....	T, 40,800 U, 44,320	2	19
Feb. 28	128		134 132 268	13½ 13½ 5 0	1,393 1,372 Igniter.		577	0	....	J, 43,320 O, 44,420	2	17

Watervliet Arsenal, at Sandy Hook Proving Ground, from February 27 to March 6, 1895.

for accuracy at 1 mile.]

Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Wind from right and rear, 30°. 20 miles an hour; barometer, 30.10; thermometer, 42°; humidity, 69.	Struck target 8 feet below, 12 feet right	Plane of fire for 2 points windage is 3.74 feet to the left of the center of the bull's-eye. Aimed by Scott sight No. 626, attached to the right trunnion. Uncompressed coppers of 1890 used in J gauge. 40,000 coppers of 1893 used in gauge (). Aimed at the top left-hand corner of target.
	Struck target 7 feet 2 inches below, 6 feet left..	
	Struck target 6 feet 5 inches below, 8 inches right.	
	Struck target 4 feet 5 inches below, 1 foot 9 inches right.	
	Struck target 4 feet below, 2 feet 8 inches right.	
	Struck target 11 feet below, 17½ feet left	
	Struck target 2 feet 5 inches below center.....	
	Struck target 4 feet 8 inches below, 1½ inches left. Firing suspended on account of darkness and ships in line of fire.	
Wind from right, 90°, 10 miles an hour; barometer, 29.22; thermometer, 44°; humidity, 78.	Struck target 7½ feet below, 1½ feet right......	
	Struck target 2 feet below, 2½ feet right.......	
	Struck target 11½ feet below, 1½ feet left. Firing suspended on account of haze.	

Record of firing with 10-inch B. L. rifle, Crozier wire-wound (weight 67,300

[Object of firing, to test gun

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Powder. No. of prisms.	Projectile. Kind.	Projectile. Weight.	Elevation, quadrant.	Pressure per square inch of bore.	Deflection points, right.	Notch pawl engaged in.
1895.			*Lbs. Oz.*			*Lbs. Oz.*		*Pounds.*		
Mar. 6	129	Du Pont's brown prismatic, X. A., lot 2.	144 13½ 144 13½ 5 290 0	1,505 1,505 Igniter.	Solid shot, lot 537.	575 8	....	T, 42,267 U, 43,455	....	17
Mar. 6	130		144 13½ 144 13½ 5 290 0	1,505 1,505 Igniter.		577 0	....	O, 41,492 V, 40,182	....	17
Mar. 6	131		144 13½ 144 13½ 5 290 0	1,505 1,505 Igniter.		577 0	....	T, 38,320 V, 40,200	....	17
Mar. 6	132		144 13½ 144 13½ 5 290 0	1,505 1,503 Igniter.		577 0	....	O, 41,920 V, 43,133	....	17
Mar. 6	133		144 13½ 144 13½ 5 290 0	1,505 1,505 Igniter.		577 0	....	T, 41,000 V, 43,060	....	17
Mar. 6	134		144 13½ 144 13½ 5 290 0	1,505 1,504 Igniter.		578 0	....	O, 42,333 V, 41,760	....	17
Mar. 6	135		144 13½ 144 13½ 5 290 0	1,505 1,505 Igniter.		578 0	....	T, 41,120 V, 42,600	....	17
Mar. 6	136		144 13½ 144 13½ 5 290 0	1,505 1,503 Igniter.		578 0	....	O, 42,945 V, 41,860	....	17
Mar. 6	137		144 13½ 144 13½ 5 290 0	1,505 1,506 Igniter.		578 0	....	T, 41,800 V, 44,070	....	17
Mar. 6	138		144 13½ 144 13½ 5 290 0	1,505 1,504 Igniter.		578 0	....	O, 41,800 V, 44,086	....	17
Mar. 6	139		144 13½ 144 13½ 5 290 0	1,503 1,503 Igniter.		576 8	....	T, 40,109 V, 44,320	....	....
Mar. 6	140		144 13½ 144 13½ 5 290 0	1,504 1,503 Igniter.		576 8	....	O, 41,120 V, 43,067	....	....

pounds), Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

for accuracy at 1 mile.]

Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.								General remarks.
	TARGET.								
	From center of target.				From center of impact.				
	Vertical.		Horizontal.		Vertical.		Horizontal.		
	Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.	
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
....	.....	5.25	1.5	.....	1.375	......	0.6	....	The throttle valve was set so that the pointer was half way between the arrow and the dot. The Scott sight when directed at the point aimed at (upper left-hand corner of target) read 40 minutes elevation, corresponding to a quadrant elevation of 1° 4'. The plane of fire was 3.74 feet to the left of the center of the bull's-eye. The projectiles used in this firing were solid shot, with considerable porosity at the base. Some were so bad that they had to be rejected. The fact that some broke up may indicate that the porosity extended for some depth, allowing gas to penetrate the shell; small pieces breaking off may account for the irregularity of flight. It would seem that for the purpose of accuracy firing more satisfactory results would have been obtained by using shell. Round 131: There was a peculiar sound during the flight of this projectile, and as it struck 82 yards in front of the target there must have been some irregularity in flight. Round 138: The shell broke up in the gun; fragments struck hoisting engine in front. Center of impact: Feet. Below .... 6.625 Right .... .9 Mean vertical deviation from center of impact..................... 1.7 Mean horizontal deviation from center of impact.................. 1.86 Mean deviation from center of impact.............................. 2.504 Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, in the presence of the Ordnance Board. Present: Maj. F. H. Phipps, Ordnance Department; Capt. F. Heath, Ordnance Department; Capt. W. Crozier, Ordnance Department. For the Board: Frank H. Phipps, Major, Ordnance Department, U. S. A., President; Frank Heath, Captain, Ordnance Department, U. S. A.
....	.....	4.5	2.25	.....	2.125	......	1.35	.....	
....	.....	......	......	.....	......	......	.....	.....	
....	.....	6	2.5	.....	.625	......	1.6	.....	
....	.....	6	3.75	.....	.625	......	1.85	.....	
....	.....	8.75	1	.....	......	2.125	.1	.....	
....	.....	8.75	2	.....	......	2.125	1.1	....	
....	.....	7.5	1.5	.....	......	.875	1.6	.....	
....	.....	10	0	.....	......	3.375	.....	.9	
....	.....	......	......	.....	......	......	.....	.....	
....	.....	5	......	7.5	1.625	......	.....	8.4	
....	.....	4.5	2	.....	2.125	......	1.1	.....	

Record of firing with 10-inch B. L. rifle, Crozier wire-wound (weight, 67,300 pounds),

Object of firing, test of

Date.	No. of fire.	Powder.				Projectile.			Elevation on wheel of sight.	Observed time of flight.	Travel of shot in bore.	Elevation.	Deflection points, right.	Instrumental velocity from muzzle.
		Kind.	Weight.		Number of prisms.	Kind.	Weight.							
1895.			*Lbs.*	*Oz.*			*Lbs.*	*Oz.*		*Secs.*	*Inches.*	° ′		
Apr. 19	141	Du Pont's brown prismatic, W. H., lot 8.	74	13½	799	Shot rebanded.	572	0	......	......	274.470	1 30	....	....
			74	13½	798									
				5	Igniter.									
			150	0										
Apr. 19	142		111	13½	1,193		570	0	......	......	274.57	0 00	....	....
			112	13½	1,204									
				5	Igniter.									
			225	0										
Apr. 19	143	Du Pont's brown prismatic, X. A., lot C.	134	13½	1,392		573	0	......	......	274.67	0 30	....	....
			132	13½	1,372									
				5	Igniter.									
			268	0										
Apr. 19	144		139	13½	1,441		570	8	......	......	274.67	0 00	....	....
			132	13½	1,373									
				5	Igniter.									
			273	0										
Apr. 19	145		139	13½	1,441		559	0	......	......	274.57	0 00	....	....
			132	13½	1,371									
				5	Igniter.									
			273	0										
Apr. 20	146		139	13½	1,440	Solid shot, lot 537.	576	0	......	......	274.57	5 00 after 4 47	....	....
			132	13½	1,473									
				5	Igniter.									
			273	0										
Apr. 20	147		134	13½	1,393		576	0	......	......	274.57	8 00	....	....
			137	13½	1,421									
				5	Igniter.									
			273	0										
Apr. 20	148		132	13½	1,373		576	0	......	......	274.57	11 00 after 10 55	....	....
			139	13½	1,441									
				5	Igniter.									
			273	0										
Apr. 20	149		137	13½	1,419		576	0	......	......	274.57	13 00 after 13 10	....	....
			134	13½	1,391									
				5	Igniter.									
			273	0										
Apr. 20	150		135	13½	1,406		576	0	......	26	274.57	13 00 after 12 56	....	....
			136	13½	1,412									
				5	Igniter.									
			273	0										
Apr. 20	151		138	13½	1,429		576	0	......	25¾	274.57	13 00 after 12 56	....	....
			139	13½	1,445									
				5	Igniter.									
			279	0										

Watervliet Arsenal, at Sandy Hook Proving Ground, from April 19 to June 8, 1895.

10-inch barbette carriage.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			
A, 16,326 C, 15,269	3	5½	......		Wind from front, 10 miles an hour.	The top carriage bound and had to be returned to battery by the aid of pinch bars.	Gun mounted on 10-inch barbette carriage. 30 gallons of oil put in cylinders. Fired to sea. Time to traverse carriage 285°, 56¾ seconds; 2 men, 1 working at a time. The guard railing on the right side interferes with the swinging of the block open. The handle of the translating roller had to be turned up, otherwise it would strike the panel of the sliding platform at elevations of 10° and above.
M, 29,667 N, 29,083	3	8	......			....	
M, 39,300 N, 39,320	3	10	......			....	
M, 40,680 N, 40,200	3	10	......			....	
M, 40,939 N, 43,533	3	10	3	9½		....	
M, 40,109 N, 40,640	3	10	3	9		The friction nut was just tight enough to elevate.	
A, 38,709 C, 38,055	3	9⅜	3	9⅜		....	
M, 40,267 N, 40,356	3	10	3	9⅝		....	
A, 39,111 C, 39,660	3	10	3	9⅝		....	
M, 40,954 N, 40,800	3	10	3	9¼		....	
A, 41,415 C, 45,436	3	10½	3	10		....	

Record of firing with 10-inch B. L. rifle, Crozier wire-wound (weight, 67,300

[Object of firing, test of

Date.	No. of fire.	Powder. Kind.		Powder. Weight. Lbs.	Powder. Weight. Oz.	Number of prisms.	Projectile. Kind.	Projectile. Weight. Lbs.	Projectile. Weight. Oz.	Elevation on wheel of sight. ° ′	Observed time of flight. Secs.	Travel of shot in bore. Inches.	Elevation. ° ′	Deflection points, right.	Instrumental velocity from muzzle.
1895.															
May 11	152	Du Pont's brown prismatic, X. A., lot 2.	B C	89 89 180	13½ 13½ 5 0	966 966 Igniter.	Solid shot, lot 537.	575	0	......	......	274.47	4 00	......	......
May 13	153		A	139 139 280	13½ 13½ 5 0	1,454 1,451 Igniter.		574	0	40	......	274.97	1 ½	......	......
May 13	154			144 144 290	13½ 13½ 5 0	1,503 1,505 Igniter.		576	0	48	......	274.27	1 11½	......	......
May 13	155			144 144 290	13½ 13½ 5 0	1,501 1,503 Igniter.		576	0	58	......	274.27	1 18½	......	......
May 13	156			144 144 290	13½ 13½ 5 0	1,502 1,503 Igniter.		577	0	60	......	274.27	1 21½	......	......
May 13	157			114 114 230	13½ 13½ 5 0	1,191 1,194 Igniter.		574	0	......	......	274.47	—6 00	......	......
May 16	158			144 144 290	13½ 13½ 5 0	1,503 1,504 Igniter.		576	0	......	......	274.47	—6 00	......	......
May 16	159			144 144 290	13½ 13½ 5 0	1,505 1,503 Igniter.		575	0	......	......	274.47	—6 00	......	......
May 16	160			144 144 290	13½ 13½ 5 0	1,504 1,503 Igniter.		574	0	......	......	274.47	—6 00	......	......
May 17	161			144 144 290	13½ 13½ 5 0	1,501 1,503 Igniter.		574	0	......	......	274.47	*Quad.* 1 19½	1½	......
May 17	162			144 144 200	13½ 13½ 5 0	1,506 1,504 Igniter.		577	0	......	......	274.47	1 9	1½	......
May 17	163			144 144 290	13½ 13½ 5 0	1,504 1,505 Igniter.		577	0	......	......	274.27	*Quad.* 1 19½ *Arc.* 1 5	1½	......

pounds), *Watervliet Arsenal, at Sandy Hook Proving Ground, etc.*—Continued.

10-inch barbette carriage.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			
A, 20,185 C, 20,457	3	8				Fired to sea	Rounds 153 to 156, inclusive, fired at 1-mile target. The elevating gear is sensitive to the slightest pressure. 32,000 coppers of 1890. Round 157, fired into sand butt.
A, 36,846 C, 36,862	3	10¾	3	10		Struck 300 yards in front, on line.	
A, 39,814 C, 41,180	3	10¼	3	10½		Struck 50 yards in front, on line.	
A, 40,444 C, 42,060	3	11	3	11		Struck 5 feet below, 2 feet 8 inches right of center.	
A, less 32,000 C, 40,489	3	11	3	11		Struck 1 foot 6 inches above, 10 feet 6 inches left of center.	
M, 26,000 N, 25,862	3	9	3	9		The shot passed through the butt in rear of trench and dropped about 60 feet to the left of butt.	
M, 41,983 N, 41,900	3	10	3	9½			
T, 42,077 U, 42,760	3	10	3	10			
M, 41,200 N, 40,982	3	10¾	3	10½			
T, 40,620 U, 41,255	3	9¼	3	8¾	Wind from rear, 20 miles an hour.	Struck target 6 feet below, 7½ feet right of center.	Fired at 1-mile target. Aimed at the upper left hand visible corner of target.
M, 42,945 N, 43,044	3	9½	3	8¾		Struck target 2¼ feet below, 12½ feet right of center.	
T, 43,111 U, 43,260	3	9½	3	9½		Struck target 5 feet below, 8 feet right of center.	

Record of firing with 10-inch B. L. rifle, Crozier wire-wound (weight, 67,300

[Object of firing, test of

Date.	No. of fire.	Powder.				Projectile.			Elevation on wheel of sight.	Observed time of flight.	Travel of shot in bore.	Elevation.	Deflection points, right.	Instrumental velocity from muzzle.
		Kind.	Weight.		Number of prisms.	Kind.	Weight.							
1895.			*Lbs.*	*Oz.*			*Lbs.*	*Oz.*	° '	*Secs.*	*Inches.*	*Quad.* ° '		
May 17	164	Du Pont's brown prismatic, X. A., lot 2.	144 144 290	13½ 13½ 5 0	1,506 1,505 Igniter.	Solid shot, lot 537.	575	0	......	......	274.37	1 21½ *Arc.* 1 2	1½	....
May 17	165		144 144 290	13½ 13½ 5 0	1,504 1,506 Igniter.		577	0	......	......	274.47	*Quad.* 1 19½ *Arc.* 1 2	1½	....
May 17	166		144 144 290	13½ 13½ 5 0	1,503 1,506 Igniter.		576	0	......	......	274.47	*Quad.* 1 25½ *Arc.* 1 9	1½	....

[Object of firing, to obtain data

Date.	No. of fire.	Powder Kind.	Weight Lbs.	Weight Oz.	Number of prisms.	Projectile Kind.	Weight Lbs.	Weight Oz.	Elevation on wheel of sight.	Observed time of flight.	Travel of shot in bore.	Elevation.	Deflection points, right.	Instrumental velocity from muzzle.
May 28	167	Du Pont's brown prismatic, X. A., lot 2.	144 144 290	13½ 13½ 5 0	1,504 1,505 Igniter.	Solid shot, lot 537.	577	0	59	......	274.27	1 ½	....	*225 ft.* 2,053 2,066
May 28	168		144 144 290	13½ 13½ 5 0	1,505 1,503 Igniter.		577	0	59	......	274.37	1 0	....	2,083 2,075 *5,093 ft.* 1,859 1,861
May 28	169		144 144 290	13½ 13½ 5 0	1,504 1,505 Igniter.		578	0	59	......	274.37	1 0	....	*225 ft.* 2,075 2,075 *5,093 ft.* 1,861 1,863
May 28	170		144 144 290	13½ 13½ 5 0	1,506 1,504 Igniter.		577	0	59	......	274.37	1 0	....	*225 ft.* 2,074 2,077
June 3	171		144 144 290	13½ 13½ 5 0	1,505 1,506 Igniter.		576	8	58	......	274.27	1 0	....	*300 ft.* 2,089 Lost.
June 3	172		144 144 290	13½ 13½ 5 0	1,506 1,505 Igniter.		577	0	55	......	274.27	2 0	....	2,089 2,090
June 3	173	B C	144 144 290	13½ 13½ 5 0	1,506 1,505 Igniter.		577	0	50	......	274.370	....	2	2,081 2,092

pounds), Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

10-inch barbette carriage.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			
T, 43,455 U, 42,527	3	9½	3	9½	Wind from rear, 20 miles an hour.	Struck target 4 feet below, 2 feet 9 inches right of center.	Fired at 1-mile target. Aimed at the upper left hand visible corner of target.
T, 43,360 U, 44,109	3	9½	3	9½		Struck target 3 feet 9 inches below, 3 feet 9 inches right of center.	
M, 42,680 N, 42,640	3	9½	3	9½		Miss to the right	

for determining the factor "C."]

Pressure per square inch of bore.	Recoil.		Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
A, 41,400 C, 42,855	3	9	....	Wind from front, 25 miles; barometer, 30.13; thermometer, 61°; humidity, 58.	Missed target 4 yards to the right.	Gun mounted on 10-inch barbette carriage. Fired at 1-mile target. Aimed at the visible upper left-hand corner of target. Scott sight No. 626 used, attached to the right trunnion. 40,000 coppers of 1893 used in rounds 167 to 173, inclusive. Distance between points at which velocities were obtained with rounds Nos. 167 to 170, inclusive, was 4,868 feet. During the firing on June 3, 1895, the top carriage bound and had to be returned to battery by the aid of pinch bars. ½ gallon of oil added to cylinders. Distance between points at which velocities were obtained with rounds Nos. 171 to 188, inclusive, was 4,793 feet.
M, 42,700 N, 43,360	3	9	....	Wind from front, 24 miles; barometer, 30.14; thermometer, 61°; humidity, 63.	Struck 2 feet 9 inches right, and 6 inches below center of target.	
A, 40,680 C, 42,477	3	10½	....	Wind from front, 24 miles; barometer, 30.14; thermometer, 64°; humidity, 60.	Struck 2 feet 9 inches right, and 6 inches above center of target.	
M, 43,240 N, 43,711	3	10½	....	Wind from front, 22 miles; barometer, 30.14; thermometer, 71°; humidity, 56.	Missed target............	
A, less than 40,000 C, 40,200	4	0	....	Wind from rear, 16 miles; barometer, 30.05; thermometer, 82°; humidity, 65.	Missed target............	
M, less than 40,000 N, less than 40,000	4	½	....	Wind from rear, 16 miles; barometer, 30.05; thermometer, 82°; humidity, 65.	Missed; went above 4 feet over the target.	
A, less than 40,000 C, less than 40,000	4	½	....	Wind from left and front, 30°, 12 miles an hour; barometer, 30.05, thermometer, 65°, humidity, 85.	Rope on shot hoist gave out after 173 rounds and was replaced by another from the storehouse. Missed screens, struck about 200 feet short in front of target.	

Record of firing with 10-inch B. L. rifle, Crozier wire-wound (weight, 67,300

[Object of firing, to obtain data

Date.	No. of fire.	Powder.					Projectile.			Elevation on wheel of sight.		Observed time of flight.	Travel of shot in bore.	Elevation.	Deflection points, right.	Instrumental velocity from muzzle.
		Kind.		Weight.		Number of prisms.	Kind.	Weight.								
1895.				*Lbs.*	*Oz.*			*Lbs.*	*Oz.*	°	'	*Secs.*	*Inches.*			*300 ft.*
June 3	174	Du Pont's brown prismatic, X. A., lot 2.	B C	144 147 393	13½ 13½ 5 0	1,506 1,533 Igniter.	Solid shot, lot 537.	577	0		53	......	274.170	......	2	2,091 2,091 *5,093 ft.* 1,886 1,889
																300 ft.
June 3	175		B C	147 144 293	13½ 13½ 5 0	1,537 1,503 Igniter.		576	0		53	......	274.270	......	1	2,100 2,100
June 3	176		B C	147 144 293	13½ 13½ 5 0	1,537 1,505 Igniter.		578	0		51	......	274.270	......	½	2,105 2,110
June 4	177		B C	147 144 293	13½ 13½ 5 0	1,537 1,504 Igniter.		577	8		55	......	273.270	......	1½	2,090 2,098
June 4	178		B C	144 144 290	13½ 13½ 5 0	1,504 1,506 Igniter.		576	0		59	......	274.370	......	1½	2,050 2,052
June 4	179		B C	144 144 290	13½ 13½ 5 0	1,504 1,506 Igniter.	Solid shot, lot 557.	577	0	1	2	......	273.270	......	0	2,074 2,078
June 4	180		B C	144 144 290	13½ 13½ 5 0	1,505 1,506 Igniter.		575	0	1	2	......	274.160	......	2	2,076 2,078
June 4	181		B C	144 144 290	13½ 13½ 5 0	1,506 1,507 Igniter.	Solid shot, lot 648.	579	0	1	2	......	275.170	......	2	Lost. 2,115
June 4	182		B C	144 144 290	13½ 13½ 5 0	1,506 1,508 Igniter.		578	0		57	......	275.170	......	1	2,109 2,107 *5,093 ft.* 1,884 1,884
																300 ft.
June 6	183		B C	143 145 290	13½ 13½ 5 0	1,498 1,518 Igniter.		578	0		59	......	275.170	......	1	2,079 2,079

pounds), Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

for determining the factor "C."]

Pressure per square inch of bore.	Recoil.		Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In.*	*Ft. In.*			
A, unreliable. C, 38,527	4	0	....	Wind from front, 21 miles an hour; barometer, 30.03; thermometer, 68°; humidity, 85.	32,000 coppers of 1890....	32,000 coppers of 1890 for rounds 174 to 176, inclusive.
M, 41,920 N, 42,622	4	0	....	Wind from front, 36 miles an hour; barometer, 30.06; thermometer, 64°; humidity, 90.	Missed screens, struck 8 feet above and 8 feet right of center of target.	
M, 38,923 N, 36,080	4	0	....	Wind from front, 30 miles an hour; barometer, 30.07; thermometer, 66°; humidity, 85.	Breechblock closed with difficulty. Missed screens, struck near 1,000-yard target and passed over mile bombproof.	
F, 43,000 G, 45,533	4	0	....	Wind from front, 13 miles an hour; barometer, 30.23; thermometer, 63°; humidity, 84.	32,000 coppers of 1890 in gauge F, and 40,000 coppers of 1893 in gauge G. Before firing this round the gas-check pad was re-covered with canvas. Shot tumbled. Missed screens, struck about 1,500 yards short and to the right of target. Ricochetted over target and went out to sea.	
F, 41,378 G, 42,945	4	0	....	Wind from front and left, 25°, 15 miles an hour; barometer, 30.26; thermometer, 65°; humidity, 75.	32,000 coppers of 1890 in gauge F, and 40,000 coppers of 1893 in gauge G. Shot tumbled. Missed screens, struck about 300 feet in front and 9 yards to the right of target.	
F, 43,340 G, 43,822	4	0	....	Wind from front and left, 25°, 12 miles an hour; barometer, 30.26; thermometer, 62°; humidity, 89.	40,000 coppers of 1893. Missed screens. Shot tumbled and passed to the right of target.	
F, 40,066 G, 44,360	3	11	....	Wind from front and left, 25°, 13 miles an hour; barometer, 30.25; thermometer 62°; humidity, 89.	Shot tumbled. Missed screens. Went above and to the right of target, struck about 2,500 yards beyond.	
F, 43,933 G, 42,600	4	0	....	Wind from front and left, 25°, 14 miles an hour; barometer, 30.24; thermometer 61°; humidity, 89.	Missed screens. Struck about 11½ feet right and 2 feet below center of target.	
F, less than 40,000 G, 44,880	4	0	....	Wind from front and left, 25°, 13 miles an hour; barometer, 30.24; thermometer 61°; humidity, 94.	Broke both screens, struck target 8 inches right and 1½ feet above center.	Up to round 180 shot with service bands had been used. The bore, at the seat of the band showed some enlargement. This and the bad practice made with the preceding 6 rounds suggested the use of shot with special bands 0.1 inch larger in diameter than the service bands. The change was very satisfactory,
A, 40,818 C, 41,091	4	0	....	Wind from right and rear, 30°, 18 miles an hour; barometer 30.10; thermometer 76°; humidity, 55.	Missed screens. Struck the top of the wooden screen frame. Struck 4 feet right and 1½ feet above center of target.	

Record of firing with 10-inch B. L. rifle, Crozier wire-wound (weight, 67,300

[Object of firing, to obtain data

Date.	No. of fire.	Powder. Kind.		Powder. Weight.		Powder. Number of prisms.	Projectile. Kind.	Projectile. Weight.		Elevation on wheel of sight.	Observed time of flight.	Travel of shot in bore.	Elevation.	Deflection points, right.	Instrumental velocity from muzzle.
1895.				*Lbs.*	*Oz.*			*Lbs.*	*Oz.*	° '	*Secs.*	*Inches.*			
June 8	184	Du Pont's brown prismatic, X. A., lot 2.	B C	142 146 290	13½ 13½ 5 0	1,487 1.530 Igniter.	Solid shot, lot 648.	578	0	55	......	275.150	....	1	*300 ft.* 2,103 2,101 *5,093 ft.* 1,892 1,892
June 8	185		B C	144 144 290	13½ 13½ 5 0	1,508 1,504 Igniter.		578	0	55	......	275.170	....	½	*300 ft.* 2,102 2,100 *5,093 ft.* 1,891 1,898
June 8	186		B C	144 144 290	13½ 13½ 5 0	1,506 1,505 Igniter.		578	0	55	......	275.170	....	½	*300 ft.* 2,104 2,106 *5,093 ft.* 1,886 1,890
June 8	187		B C	144 144 290	13½ 13½ 5 0	1,503 1,502 Igniter.		578	0	55	......	275.170	....	½	*300 ft.* 2,116 2,121 *5,093 ft.* 1,903 1,902
June 8	188		B C	144 144 290	13½ 13½ 5 0	1,505 1,504 Igniter.		577	0	55	......	275.170	....	½	*300 ft.* 2,110 2,113 2,115 *5,093 ft.* Lost. 1,897 225, 1[illegible]

pounds), Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

for determining the factor "C."]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			
A, less than 40,000 F, less than 40,000	4	0	....		Wind from left and rear, 54°, 13 miles an hour; barometer, 30.44; thermometer, 67°; humidity, 58.	Struck 9 feet 6 inches right and 3 feet 6 inches below center of target.	the practice made subsequently being very accurate. 1 quart of oil added to cylinders. Gun washed out after each round. 40,000 coppers of 1893 for rounds 180 to 187 inclusive. Velocities · taken by Lieut. C. B. Wheeler, Ordnance Department, U. S. A.; Lieut. Colden L'H. Ruggles, Ordnance Department, U. S. A.
C, less than 40,000 E, 42,964	4	0	....		Wind from left and rear, 54°, 12 miles an hour; barometer, 30.44; thermometer, 68°; humidity, 58.	32,000 coppers of 1890. Struck 7 feet right and 4 feet below center of target.	
C, 41,040 E, 41,182	4	0	....		Wind from left and rear, 54°, 16 miles an hour; barometer, 30.45; thermometer, 69°; humidity, 51.	40,000 coppers of 1893. Struck 4 feet 6 inches right and 6 feet below center of target.	
C, 44,111 E, 41,600	4	0	....		Wind from left and rear, 54°, 18 miles an hour; barometer, 30.43; thermometer, 70°; humidity, 52.	32,000 coppers of 1890 in gauge C and 40,000 coppers of 1893 in gauge E. Struck 5 feet right and 4 feet below center of target.	
C, 45,840 E, 41,983	4	0	....		Wind from left and rear, 54°, 13 miles an hour; barometer, 30.40; thermometer, 71°; humidity, 52.	40,000 coppers of 1893. Struck 3 feet 4 inches right and 4 feet below center of target. Reading with one instrument only.	

Record of firing with 10-inch B. L. rifle, Crozier wire-wound (weight 67,300

[Object of firing, to test the

No. of fire.	Powder.				Projectile.			Elevation by Scott sight.		Elevation by elevation indicator.	Travel of shot in bore.	Elevation.			Pressure, per square inch of bore.
	Kind.	Weight.		Number of prisms.	Kind.	Weight.		On wheel.	Deflection points, right.						
		Lbs.	*Oz.*			*Lbs.*	*Oz.*	′		° ′	*Inches.*		°	′	*Pounds.*
189	Du Pont's brown prismatic, X. A., lot 2.	144 144 290	13½ 13½ 5 0	1,503 1,500 Igniter.	Shot rebanded.	560	0	55	½	......	275.070	Quadrant. Arc.......	1 1	25 40	O, 43,455 P, 42,527
190		144 144 290	13½ 13½ 5 0	1,502 1,502 Igniter.		573	0	53	½	......	275.070	Quadrant. Arc.......	1 1	22 44	O, 42,491 P, 43,044
192		144 144 290	13½ 13½ 5 0	1,505 1,502 Igniter.		573	0	53	½	......	274.970	Quadrant. Arc.......	1 1	22 43	O, 43,867 P, 44,077
194		144 144 290	13½ 13½ 5 0	1,505 1,502 Igniter.		572	0	53	½	......	274.970	Quadrant. Arc.......	1 1	23 43	O, 43,089 P, 44,460
196		144 144 290	13½ 13½ 5 0	1,504 1,502 Igniter.		572	0	53	½	......	274.970	Quadrant. Arc.......	1 1	23 43	O, 44,980 P, 45,020
198		144 144 290	13½ 13½ 5 0	1,502 1,505 Igniter.	Shot, lot 648.	567	0	53	½	......	274.870	Quadrant. Arc.......	1 1	23 43	J, 44,520 K, 44,667
200		144 144 290	13½ 13½ 5 0	1,504 1,505 Igniter.		577	0	53	½	......	274.970	Quadrant. Arc.......	1 1	21 42½	H, 43,545 J, 45,040
202		144 144 290	13½ 13½ 5 0	1,502 1,503 Igniter.		577	0	53	½	......	274.870	Quadrant. Arc.......	1 1	22 43	O, 43,455 P, 46,600
204		144 144 290	13½ 13½ 5 0	1,502 1,502 Igniter.		577	0	53	½	......	274.970	Quadrant. Arc.......	1 1	23 41	O, 43,491 P, 43,644

pounds), Watervliet Arsenal, at Sandy Hook Proving Ground, on July 12, 1895.

accuracy of elevation indicator.]

Recoil.		Counter recoil.		Azimuth.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.								General remarks.
						TARGET WITH SCOTT SIGHT.								
						From center of target.				From center of impact.				
						Vertical.		Horizontal.		Vertical.		Horizontal.		
						Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.	
Ft.	*In.*	*Ft.*	*In.*			*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	
3	10	3	7	3	From right and rear, 50°, 4 miles an hour.	....	....	....	....	....	....	....	....	
3	10	3	10	4		....	5	2	....	....	0.344	1.75	....	
4	0	4	0	4	From front and left, 42°, 15 miles an hour.	....	3.5	3	....	....	1.844	2.75	....	Gun mounted on 10-inch barbette carriage. Barometer, 30.31; thermometer, 73°; humidity, 69. Round 189: Sighting shot. Struck target 5 feet above and ½ foot left of center. Round 192: The last quarter of a turn in translation made with some difficulty. The chassis rail has an inclination of 4° 8′ by quadrant, measured before firing. Gun washed out after each shot. Fired at 1-mile target. The vertical shaft of traversing gear should be pinned through the bevel gear to prevent it slipping down.
4	0	4	0	4	From right and front, 43°, 15 miles an hour.	....	5	....	2	....	0.344	....	2.25	
4	0	4	0	5		....	4.5	....	2.5	....	0.844	....	2.75	
4	0	4	0	5		....	6	0.5	....	0.656	....	0.25	....	
4	0	4	0	5	From right and front, 80°, 15 miles an hour.	....	4	....	2	....	1.344	....	2.25	
4	0	4	0	4		....	11	3.5	....	5.656	....	3.25	....	
4	0	4	0	4		....	3.75	....	0.5	....	1.594	....	0.75	

Center of impact:	Feet.
Below	5.344
Right	0.25
Mean vertical deviation from center of impact	1.578
Mean horizontal deviation from center of impact	2
Mean deviation from center of impact	1.89

Record of firing with 10-inch B. L. rifle, Crozier wire-wound (weight 67,300 pounds),

[Object of firing, to test the

No. of fire.	Powder.			Projectile.		Elevation by Scott sight.		Elevation by elevation indicator.	Travel of shot in bore.	Elevation.	Pressure, per square inch of bore.
	Kind.	Weight.	Number of prisms.	Kind.	Weight.	On wheel.	Deflection points, right.				
		Lbs. Oz.			*Lbs. Oz.*	'		° '	*Inches.*	° '	*Pounds.*
191	Du Pont's brown prismatic, X. A., lot 2.	144 13½ 144 13½ 5 290 0	1,505 1,502 Igniter.	Shot rebanded.	573 0	....	.....	1 44	274.970	Quadrant. 1 23	O, 44,109 P, 44,600
193		144 13½ 144 13½ 5 290 0	1,505 1,502 Igniter.		572 0	....	.....	1 44	274.970	Quadrant. 1 24	J, 44,733 K, 43,644
195		144 13½ 144 13½ 5 290 0	1,505 1,504 Igniter.		576 0	....	.....	1 44	274.960	Quadrant. 1 24	J, 43,156 K, 43,644
197		144 13½ 144 13½ 5 290 0	1,504 1,503 Igniter.		573 0	....	.....	1 44	274.970	Quadrant. 1 24	H, 45,380 J, 44,260
199		144 13½ 144 13½ 5 290 0	1,504 1,503 Igniter.	Shot, lot 648.	578 0	....	.....	1 44	274.970	Quadrant. 1 23	O, 46,840 P, 45,080
201		144 13½ 144 13½ 5 290 0	1,503 1,502 Igniter.		577 0	....	.....	1 44	274.970	Quadrant. 1 23	H, 45,740 I, 45,444
203		144 13½ 144 13½ 5 290 0	1,502 1,503 Igniter.		578 0	....	.....	1 44	274.970	Quadrant. 1 23	H, 45,660 I, 44,182
205		144 13½ 144 13½ 5 290 0	1,505 1,505 Igniter.		576 0	....	.....	1 44	274.970	Quadrant. 1 24	H, 45,080 I, 44,860

Watervliet Arsenal, at Sandy Hook Proving Ground, on July 12, 1895—Continued.

accuracy of elevation indicator.]

Recoil.		Counter recoil.		Azimuth.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc. TARGET WITH ELEVATION INDICATOR.								General remarks.
						From center of target.				From center of impact.				
						Vertical.		Horizontal.		Vertical.		Horizontal.		
						Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.	
Ft.	*In.*	*Ft.*	*In.*			*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	
4	0	3	11	4	From front and left, 50°, 4 miles an hour.	....	3	3	....	.....	1.281	3.875	.....	Round 193: Fillet on the end of the translating roller found burred; filed off. This was the cause of the difficulty in round 192. Round 195: The wind swung the rear of the carriage around and it was impossible to keep the carriage on the proper point. The sprocket chain was tightened to correct this. Fired at 1-mile target.
4	0	4	0	4	From front and left, 42°, 10 miles an hour.	....	2.5	2	....	.....	0.781	2.875	.....	
4	0	4	0	4	From front and left, 42°. 15 miles an hour.	....	4.5	....	2	.....	2.781	.....	1.125	
4	0	4	0	4		....	2.5	....	2	.....	0.781	.....	1.125	
4	0	4	0	4	From front and right, 30°, 15 miles an hour.	4.5	....	....	7	6.219	.....	.....	6.125	
4	0	4	0	4		....	4	5.5	....	.....	2.281	6.375	.....	
4	0	4	0	4		....	1.75	....	4	.....	0.31	.....	3.125	
4	0	4	0	4	From front and right, 37°, 15 miles an hour.	0		....	2.5	1.719	.....	.....	1.625	

Center of impact:	Feet.
Below	1.719
Left	0.875
Mean vertical deviation from center of impact	1.983
Mean horizontal deviation from center of impact	3.281
Mean deviation from center of impact	2.294

Record of firing with 10-inch B. L. rifle, Crozier wire-wound (weight, 67,300 pounds),

[Object of firing, exhibition before

Date.	No. of fire.	Powder. Kind.	Powder. Weight. Lbs.	Powder. Weight. Oz.	Powder. Number of prisms.	Projectile. Kind.	Projectile. Weight.	Shot marked.	Travel of shot in bore.	Depression.	Instrumental velocity from muzzle.
1895.			*Lbs.*	*Oz.*			*Pounds.*		*Inches.*	'	*Feet.*
July 18	206	Du Pont's brown prismatic, X. A., lot 2.	144 144 290	13½ 13½ 5 0	1,506 1,506 Igniter.	Shot, lot 648.	577	....	274.770	29	....
July 18	207		144 144 290	13½ 13½ 5 0	1,505 1,506 Igniter.		576	....	274.770	29	....

[Object of firing,

Date.	No. of fire.	Powder. Kind.	Powder. Weight. Lbs.	Powder. Weight. Oz.	Powder. Number of prisms.	Projectile. Kind.	Projectile. Weight.	Shot marked.	Travel of shot in bore.	Depression.	Instrumental velocity from muzzle.
1895.											
Sept. 24	208	Du Pont's brown prismatic, X. A., lot 3.	119 119 240	13½ 13½ 5 0	1,265 1,265 Igniter.	Solid shot, lot 648.	577	Not marked	274.77	46	1,840 1,840
Sept. 24	209		129 139 270	13½ 13½ 5 0	1,371 1,477 Igniter.		579	5	274.87	46	1,997 1,988
Sept. 24	210		147 134 283	13½ 13½ 5 0	1,560 1,423 Igniter.		577	6	274.77	46	2,056 2,063
Oct. 12	211	Du Pont's brown prismatic, X. A., lot 3 B.	141 140 283	13½ 13½ 5 0	1,490 1,481 Igniter.	Solid shot, lot 537; band calipered 10.42 inches.	578	....	275.07	36½	....
Oct. 12	212		141 140 283	13½ 13½ 5 0	1,490 1,481 Igniter.		578	....	275.07	36½	....
Oct. 12	213		140 141 283	13½ 13½ 5 0	1,491 1,490 Igniter.		575	12	275.07	36½	....
Oct. 12	214		140 141 283	13½ 13½ 5 0	1,480 1,491 Igniter.		576	13	275.07	36½	....
Oct. 12	215		140 141 283	13½ 13½ 5 0	1,481 1,490 Igniter.		579	14	275.07	36½	....

Watervliet Arsenal, at Sandy Hook Proving Ground, from July 18 to November 9, 1895.

the Board of Ordnance and Fortification.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			
H, 43,260 I, 43,600	4	0	4	0	....	....	Firing conducted by Lieut. W. S. Peirce, assistant proof officer.
H, 43,689 I, 44,077	4	0	4	0	....	....	

to prove powder.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
H, 31,871 I, 32,855	5	9	5	9	Wind from left, 90°, 10 miles an hour; barometer, 30.30; thermometer, 71°; humidity, 72.	28,000 coppers of 1890, gauge H; 32,000 coppers of 1895, gauge J.	Gun mounted on 10-inch proof carriage. Obturating friction primers. Fired into sand butt No. 1. The locking of rotating handle causes some trouble, as the noncommissioned officer in charge of the loading can not tell without trial which way the wing nut ought to be turned to lock the handle. The bronze bushing which is screwed into the rotating handle unscrews, and should be fastened in some way. The elevating band used with the 10-inch B. C. disappearing carriage is retained on the gun to counteract the muzzle preponderance that the gun has. Firing conducted by Lieut. C. B. Wheeler. Velocities taken by Lieut. C. L'H. Ruggles.
H, 38,880 I, 38,689	6	4	6	4		32,000 coppers of 1895.........	
H, 43,000 I, 42,940	6	5	6	5		32,000 coppers of 1895.........	
O, 42,333 K, 40,400	6	6	....		Wind from front and right, 30°, 20 miles an hour; barometer, 30.03; thermometer, 60°; humidity, 94.	....	Gun mounted on 10-inch proof carriage. Obturating friction primers. Fired into sand butt No. 1.
O, 42,356 K, 42,200	6	6	....			....	
O, 42,244 K, 42,455	6	6	....			....	
O, 44,689 K, 42,433	6	6	....			....	
O, 43,920 K, 44,022	6	6	....			....	

Record of firing with 10-inch B. L. rifle, Crozier wire-wound (weight, 67,300

[Object of firing,

Date.	No. of fire.	Powder.			Projectile.		Shot marked.	Travel of shot in bore.	Depression.	Instrumental velocity from muzzle.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
1895.			*Lbs.* *Oz.*			*Pounds.*		*Inches.*	′	*Feet.*
Oct. 14	216	Du Pont's brown prismatic. X. A., lot 3.	141 13½ 140 13½ 5 283 0	1,496 1,485 Igniter.	Solid shot, lot 623; band callipered 10.40 inches.	574	15	274.47	36	....
Oct. 14	217	Du Pont's brown prismatic. X. A., lot 2 D.	144 13½ 144 13½ 5 290 0	1,502 1,502 Igniter.		575	16	274.57	36	....
Oct. 14	218		144 13½ 144 13½ 5 290 0	1,503 1,502 Igniter.		577	17	274.57	36	....
Oct. 14	219	Du Pont's brown prismatic, X. A., lot 3 B.	140 13½ 141 13½ 5 283 0	1,480 1,491 Igniter.		577	18	274.57	36	....
Oct. 14	220		140 13½ 141 13½ 5 283 0	1,480 1,491 Igniter.		575	19	274.57	36	....
Oct. 15	221		140 13½ 141 13½ 5 283 0	1,481 1,490 Igniter.	Shot, lot 537; band callipered 10.42 inches.	578	20	274.97	36	....
Oct. 15	222		140 13½ 141 13½ 5 283 0	1,480 1,490 Igniter.		578	21	274.77	38	....
									Elevation. ° ′	
Oct. 15	223		140 13½ 141 13½ 5 283 0	1,481 1,491 Igniter.		578	....	274.97	3 30	....
Oct. 16	224		140 13½ 141 13½ 5 283 0	1,480 1,491 Igniter.		572	....	274.97	......	....
Oct. 16	225		140 13½ 141 13½ 5 283 0	1,480 1,491 Igniter.		577	....	274.87	......	....
Oct. 16	226		140 13½ 141 13½ 5 283 0	1,480 1,493 Igniter.		577	....	274.97	......	....
Oct. 16	227		140 13½ 141 13½ 5 283 0	1,482 1,490 Igniter.		578	....	274.97	......	....

pounds), Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

to prove powder.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			
O, 42,200 K, 41,680	6	6	....		Wind from left, 25 miles an hour; barometer, 30.10; thermometer, 61°; humidity, 54.	This charge is what remained of the sample.	Gun mounted on 10-inch proof carriage. Obturating friction primers. Fired into sand butt No. 1.
I, 41,476 P, 41,700	6	6	....			Charges put up July 9, 1895...	
O, 41,558 K, 40,000	6	6	....			Charges put up July 9, 1895...	
O, 41,537 K, 41,394	6	6	....			....	
O, 41,120 K, 40,000	6	6	....			Shot came out of butt and fell to the right.	
J, 41,820 P, 41,335	6	5¼	....		Wind from front and left, 15°, 13 miles an hour.	....	
O, 42,489 K, 42,333	6	5¼	....			....	
J, 41,700 P, 41,580	6	5¼	....			The tray-latch spring-bolt was smoothed off after this round.	
O, 42,200 K, 42,091	6	6	....		Wind from front and left, 30°, 11 miles an hour.	....	
I, 41,883 P, 42,064	6	6	....			....	
O, 42,962 K, 43,111	6	6	....			....	
I, 42,891 P, 42,780	6	6	....			....	

Record of firing with 10-inch B. L. rifle, Crozier wire-wound (weight 67,200

[Object of firing,

Date.	No. of fire.	Powder.			Projectile.		Shot marked	Travel of shot in bore.	Elevation.	Instrumental velocity from muzzle.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
1895.			*Lbs. Oz.*			*Pounds.*		*Inches.*		*Feet.*
Oct. 16	228	Du Pont's brown prismatic, X. A., lot 3 B.	140 13½ 141 13½ 5 283 0	1,480 1,490 Igniter.	Shot, lot 537; band calipered 10.42 inches.	578	....	274.97	......	....
Oct. 16	229		140 13½ 141 13½ 5 283 0	1,482 1,490 Igniter.		578	....	274.97	......	....
Oct. 16	230		140 13½ 141 13½ 5 283 0	1,482 1,490 Igniter.		577	....	274.97	......	....
Oct. 16	231		140 13½ 141 13½ 5 283 0	1,480 1,490 Igniter.		576	....	274.97	3° 29′	....
Oct. 24	232	X.A., lot 1 A.	137 13½ 140 13½ 5 279 0	1,421 1,450 Igniter.	Shot, lot 537.	578	....	274.87	3 30	....
Oct. 24	233	Du Pont's brown prismatic, X. A., lot 3 A.	140 13½ 141 13½ 5 283 0	1,481 1,492 Igniter.		578	....	274.87	3 30	....
Oct. 24	234		140 13½ 141 13½ 5 283 0	1,481 1,491 Igniter.		575	....	274.77	3 30	....
Oct. 24	235		140 13½ 141 13½ 5 283 0	1,482 1,493 Igniter.		576	....	274.87	3 30	....
Oct. 24	236		140 13½ 141 13½ 5 283 0	1,482 1,493 Igniter.		577	....	274.87	3 30	....
Oct. 24	237		141 13½ 140 13½ 5 283 0	1,496 1,482 Igniter.	Shot rebanded.	572	....	274.77	3 30	....
Oct. 24	238		141 13½ 140 13½ 5 283 0	1,496 1,482 Igniter.		571	....	274.57	3 30	....
Oct. 24	239		141 13½ 140 13½ 5 283 0	1,493 1,482 Igniter.		573	....	274.47	3 30	....

***pounds*), *Watervliet Arsenal, at Sandy Hook Proving Ground, etc.*—Continued.**

to prove powder.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			
O, 42,545 K, 42,378	6	6	....		Wind from front and left, 30°, 11 miles an hour.	....	Gun mounted on 10-inch proof carriage. Obturating friction primers. Fired into sand butt No. 1.
I, 42,509 P, 43,044	6	6	....			....	
O, 43,360 K, 43,491	....		....			....	
O, 41,620 K, 41,917	6	6	....			40,000 coppers of 1893	
K, 44,200 O, 44,778	6	5	....		Wind from right, 15 miles an hour; barometer, 30.33; thermometer, 50°; humidity, 65.	There is a leakage of oil around the cylinder heads and obturating bar bolts.	40 000 coppers of 1893.
K, 41,933 O, 42,418	6	6	....			....	
K, 42,378 O, 42,564	6	6	....			....	
K, 41,938 O, 42,909	6	6	....			....	
K, 41,520 O, 42,267	6	6	....			....	
K, less than 40,000. O, 42,660	6	6	....			....	
K, less than 40,000. O, 43,280	6	6	....			....	
H, 42,356 I, 41,680	6	6	....			....	

Record of firing with 10-inch B. L. rifle, Crozier wire-wound (weight, 67,300

[Object of firing,

Date.	No. of fire.	Powder.			Projectile.		Shot marked.	Travel of shot in bore.	Elevation.	Instrumental velocity from muzzle.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
1895.			*Lbs. Oz.*			*Pounds.*		*Inches.*	° ′	*Feet.*
Oct. 24	240	Du Pont's brown prismatic, X. A., lot 3 A.	140 13½ 141 13½ 5 283 0	1,482 1,493 Igniter.	Shot rebanded.	574	....	274.37	3 30	....
Oct. 24	241		140 13½ 141 13½ 5 283 0	1,482 1,493 Igniter.		574	....	274.37	3 30	....
Oct. 30	242	Du Pont's brown prismatic, X. A., lot 3 D.	140 13½ 141 13½ 5 283 0	1,478 1,486 Igniter.	Shot, lot 537.	575	21	274.67	*Depression.* 33	....
Oct. 30	243		141 13½ 140 13½ 5 283 0	1,489 1,479 Igniter.		579	22	274.77	33	....
Oct. 30	244		141 13½ 140 13½ 5 283 0	1,488 1,478 Igniter.		580	23	274.67	33	....
Oct. 30	245		141 13½ 140 13½ 5 283 0	1,492 1,472 Igniter.		580	24	274.97	37	....
Oct. 30	246		141 13½ 140 13½ 5 283 0	1,489 1,478 Igniter.		580	25	274.87	35	....
Oct. 30	247		141 13½ 140 13½ 5 283 0	1,489 1,478 Igniter.		577	26	274.77	35	....
Oct. 30	248		141 13½ 140 13½ 5 283 0	1,489 1,478 Igniter.		576	27	274.77	35	....
Oct. 30	249		141 13½ 140 13½ 5 283 0	1,490 1,479 Igniter.		577	28	274.67	35	....
Oct. 30	250		141 13½ 140 13½ 5 283 0	1,491 1,479 Igniter.		575	29	274.67	33	....
Oct. 30	251		141 13½ 140 13½ 5 283 0	1,491 1,479 Igniter.		576	30	274.67	32	....

pounds), Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

to prove powder.]

Pressure per square inch of bore.	Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft. In.*	*Ft. In.*			
H, 42,909 I, 42,378	6 6	....	Wind from right, 15 miles an hour; barometer, 30.33; thermometer, 56°; humidity, 65.	....	40,000 coppers of 1893.
H, 43,509 I, 42,873	6 6	....		....	
I, 40,964 O, 41,055	....	....	Wind from front and left, 20°, 6 miles an hour; barometer, 30.65; thermometer, 49°; humidity, 42.	....	Impressions taken before round 242. New steps put on right side of carriage.
I, 41,036 O, 40,909	....	....		Shot came out of butt	
H, 42,244 I, 41,309	....	....		....	
I, 40,945 O, 41,091	....	....		....	
H, 40,222 I, 41,345	....	....		....	
I, 41,055 O, 41,400	....	....		....	
H, 43,067 I, 42,473	....	....		....	
I, 41,382 O, 40,182	....	....		....	
H, 40,091 I, 41,236	....	....		....	
I, 41,073 O, 40,055	....	....		....	

Record of firing with 10-inch B. L. rifle, Crozier wire-wound (weight, 67,300

[Object of firing.

Date.	No. of fire.	Powder.			Projectile.		Shot marked.	Travel of shot in bore.	Depression.	Instrumental velocity from muzzle.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
1895.			*Lbs.* *Oz.*			*Pounds.*		*Inches.*	'	*Feet.*
Nov. 9	252	Du Pont's brown prismatic, X. A., lot 3 D.	140 13½ 141 13½ 5 283 0	1,481 1,490 Igniter.	Shot, lot 537.	576	31	274.97	32	....
Nov. 9	253		140 13½ 141 13½ 5 283 0	1,481 1,487 Igniter.		578	32	274.87	32	....
Nov. 9	254		140 13½ 141 13½ 5 283 0	1,490 1,480 Igniter.		577	33	274.77	32	....
Nov. 9	255		140 13½ 141 13½ 5 283 0	1,479 1,490 Igniter.		578	34	274.87	32	....
Nov. 9	256		141 13½ 140 13½ 5 283 0	1,489 1,479 Igniter.		577	35	274.87	32	....

pounds), *Watervliet Arsenal, at Sandy Hook Proving Ground, etc.*—Continued.

to prove powder.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			
O, 40,620 P, 40,280	6	3	6	3	Wind from right, 14 miles an hour; barometer, 30; thermometer, 70°; humidity, 77.	40,000 coppers of 1893	Gun mounted on 10-inch proof carriage. Obturating friction primers. Fired into sand butt No. 1.
O, 41,382 P, 41,273	6	5	6	5		Nuts of holding-down bolts tightened.	
O, 41,000 P, 41,164	6	5	6	5		....	
O, 40,578 P, 41,345	6	5	6	5		....	
O, 41,660 P, 42,127	6	5	6	1½		....	

Record of firing with 10-inch B. L. rifle, Crozier wire-wound (weight, 67,300 pounds),

[Object of firing, for

Date.	No. of fire.	Powder.				Projectile		Shot marked.	Elevation on wheel of sight.	Travel of shot in bore.	Elevation.		
		Kind.	Weight.		Number of prisms.	Kind.	Weight.						
1895			*Lbs.*	*Oz.*			*Pounds.*		′	*Inches.*		°	′
Nov. 11	257	Du Pont's brown prismatic. X. A., lot 3 D.	141 140 283	13½ 13½ 5 0	1,490 1,481 Igniter.	Shot, lot 537.	571	....	54	274.57	Quadrant.	1	28
Nov. 14	258		141 140 283	13½ 13½ 5 0	1,490 1,481 Igniter		578	....	58	274.97	Quadrant.	1	33
Nov. 18	259	Du Pont's brown prismatic, X. A., lot 3.	140 141 283	13½ 13½ 5 0	1,479 1,490 Igniter.		576	....	58	274.97	Quadrant. Sight.....	1 1	33 10
Nov. 18	260		140 141 283	13½ 13½ 5 0	1,480 1,490 Igniter.		575	....	58	274.97	Quadrant. Sight.....	1 1	33 10
Nov. 18	261		140 141 283	13½ 13½ 5 0	1,480 1,492 Igniter.		576	....	58	274.87	Quadrant. Sight.....	1 1	33 10
Nov. 18	262		140 141 283	13½ 13½ 5 0	1,480 1,493 Igniter..		577	....	58	274 87	Quadrant Sight.....	1 1	33 10
Nov. 19	263		140 141 283	13½ 13½ 5 0	1,482 1,495 Igniter.		578	....	58	274 77	Tel. sight. Quadrant.	1 1	20 32
Nov. 19	264		140 141 283	13½ 13½ 5 0	1,485 1,495 Igniter.		576	....	58	274.97	Quadrant. Tel. sight.	1 1	30½ 20½
											Depression.		′
Nov. 23	265		140 141 283	13½ 13½ 5 0	.... Igniter.		575	Not marked.	....	274.97			32
Nov. 23	266		140 141 283	13½ 13½ 5 0	.... Igniter.	Rebanded.	573	37	....	274.07			30

Watervliet Arsenal, at Sandy Hook Proving Ground, from November 14 to December 4, 1895.

accuracy at 1 mile]

Deflection points, right.	Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
	Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			
0	O, less than 40,000 P, less than 40,000	6	4	6	0	Wind from left and front, 60°, 22 miles an hour; barometer, 30.43; thermometer, 51°; humidity, 81.	....	Fired at 1-mile target. Aimed at the upper left-hand corner of target.
0	H, 40,222 I, 40,178	6	4	6	4		....	
1	O, 40,333 P, 40,640	6	4½	6	4½	Wind from right, 90°, 10 miles an hour; barometer, 30.05, thermometer 60°; humidity, 50.	Struck target 6½ feet below, 1 foot right of center.	Gun mounted on 10-inch proof carriage. Obturating friction primers. Aimed at 1-mile target. Aimed by Scott sight No. 626 at the upper left-hand corner of target. Rod attached to front transom, holding elevating screw, straightened before firing, bent after first shot. The first countersunk bolt in rear on right side of under plate of top carriage found loose after round 262. Gun washed out and examined after each round. 40,000 coppers of 1893.
1	I, 41,867 K, 40,964	6	5	6	5	Wind from right, 90°, 14 miles an hour; barometer, 30 05; thermometer, 61°, humidity, 49.	Struck target 3 feet below, 2 feet right of center.	
1	O, 41,740 P, 43,036	6	5	6	5	Wind from right, 90°, 16 miles an hour; barometer, 30.05; thermometer, 60°; humidity, 48	Struck target 4 feet below center.	
1	I, 40,873 K, 40,436	6	5	6	3		Struck target 3 feet below, 2 feet left of center.	
1 4½	O, 40,244 P, 41,480	6	5	6	3	Wind from right, 90°. 4 miles an hour; barometer, 30.01; thermometer, 56°; humidity, 71.	Aimed by Scott telescopic sight at the upper right-hand corner; struck target 1 foot below, 4 feet right of center.	
3½	I, 40,127 K, 40,091	6	5	6	5	Wind from rear, 0°, 3 miles an hour; barometer, 30.02; thermometer, 53°; humidity, 75.	Struck target 8½ feet below, 7 feet right of center.	
......	O, 41,345 P, 41,420	6	4	6	4	Wind from rear, 8 miles an hour; barometer, 30.44; thermometer, 58°; humidity, 61.	....	Gun mounted on 10-inch proof carriage. Obturating friction primers. Fired into sand butt No. 1. 40,000 coppers of 1890.
......	O, 40,582 P, 40,680	6	4	6	0		Shot came out of butt and fell to the right.	

Record of firing with 10-inch B. L. rifle, Crozier wire-wound (weight, 67,300

[Object of firing, for

Date.	No. of fire.	Powder.				Projectile.		Shot marked.	Elevation on wheel of sight.	Travel of shot in bore.	Depression.
		Kind.	Weight.		No. of prisms.	Kind.	Weight.				
1895.			*Lbs.*	*Oz.*			*Pounds.*			*Inches.*	′
Nov. 23	267	Du Pont's brown prismatic, X. A., lot 3.	140 141 283	13½ 13½ 5 0	.... Igniter.	Solid shot. Lot 648.	578	38	....	274.07	25
Nov. 23	268		140 141 283	13½ 13½ 5 0	.... Igniter.	Lot 537.	575	39	....	274.67	24
Nov. 23	269		140 141 283	13½ 13½ 5 0	.... Igniter.		576	40	....	274.67	24
Nov. 23	270		140 141 283	13½ 13½ 5 0	.... Igniter.		576	41	....	274.67	24
											Elevation. ° ′
Dec. 4	271	Du Pont's brown prismatic, X. A., lot 3 C.	140 141 283	13½ 13½ 5 0	1,482 1,493 Igniter.	Solid shot, lot 537, large band.	576	....	....	274.87	Quadrant. 1 33 Sight..... 1 23
Dec. 4	272		140 141 283	13½ 13½ 5 0	1,478 1,489 Igniter.		575	....	....	274.77	Quadrant. 1 31 Sight..... 1 23
Dec. 4	273		140 141 283	13½ 13½ 5 0	1,478 1,489 Igniter.		576	....	....	274.77	Quadrant. 1 32½ Sight..... 1 23
Dec. 4	274		140 141 283	13½ 13½ 5 0	1,478 1,488 Igniter.		575	....	....	274.77	Quadrant. 1 32 Sight..... 1 23
Dec. 4	275		140 141 283	13½ 13½ 5 0	1,478 1,488 Igniter.		576	....	....	274.67	Quadrant. 1 32½ Sight..... 1 23

pounds), Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

accuracy at 1 mile.]

Deflection points, right.	Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.								General remarks.
	Pounds.	Ft.	In.	Ft.	In.										
......	O, 41,145 P, 41,236	6	4	6	0	Wind from rear, 8 miles an hour; barometer, 30.44; thermometer, 58°; humidity, 61.	....								Gun mounted on 10-inch proof carriage. Obturating friction primers. Fired into sand butt No. 1. 40,000 coppers of 1890.
......	O, 41,364 P, 41,760	6	4	6	0		....								
......	O, less than 40,000 P, 40,333	6	4	6	0		....								
......	J, 40,350 K, 40,145	6	4	6	0		....								
							TARGET.								
							From center of target.				From center of impact.				
							Vertical.		Horizontal.		Vertical.		Horizontal.		
							Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.	
							Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	
1½	O, 40,055 P, 40,109	6	4	6	4	Wind from left and rear, 70°, 5 miles an hour; barometer, 30.37; thermometer, 29°; humidity, 66.	1	...	...	7	2.8	...	...	0.4	Gun mounted on 10 inch proof carriage. Obturating friction primers. Aimed by Scott sight No. 627 at the upper left-hand corner of 1-mile target. Gun washed out after each round. Center of impact: Feet. Below .... 1.8 Left .... 6.6 Mean vertical deviation from center of impact .... 1.84 Mean horizontal deviation from center of impact .... 0.64 Mean deviation from center of impact .... 1.95 Firing conducted by Lieut. W. S. Peirce, Ordnance Department, in the presence of the Ordnance Board. Present: Capt. F. Heath, Ordnance Department; Capt. W. Crozier, Ordnance Department. W. S. Peirce, Lieutenant, Ordnance Department, U. S. A. For the board: Frank H. Phipps, Major, Ordnance Department, U. S. A., president.
1½	O, 40,582 P, 40,311	6	4	6	4	Wind from left and rear, 45°, 4 miles an hour; barometer, 30.37; thermometer, 31°; humidity, 58.	0		...	5	1.8	...	1.6	...	
1½	O, 40,400 P, 40,400	6	4	6	4	Wind from rear, 5 miles an hour; barometer, 30.36; thermometer, 31°; humidity, 58.	...	3	...	7	...	1.2	...	.4	
1½	O, 40,182 P, 40,109	6	4	6	4		...	5	...	7	...	3.2	...	.4	
1½	O, 40,067 P, 40,178	6	4	6	4		...	2	...	7	...	.2	...	.4	

Star gauging of 10-inch B. L. rifle (steel), wire-wound,

[Gun star gauged, under the directions of Lieuten-

LANDS.

[9.99845-inch ring and 10-inch point. Temperature: June 29, 1894, outside bore 75°, inside 80°; August 27, 1894, outside bore 68°, inside 87°; June 14, 1895, outside bore 83°, inside 100°; December 18, 1895, outside bore 40°, inside 40°.]

From muzzle.	Before firing, June 29, 1894.	After 67 rounds, Aug. 27, 1894.	Increase.	After 117 rounds, Feb. 25, 1895.	Increase.	After 188 rounds, June 14, 1895.	Increase.	After 275 rounds, Dec. 18, 1895.	Increase.	Total increase.
Inches.	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inch.*
0	10.0010	10.0035	.0025	10.0035	.0000	10.0085	.0050	10.0100	.0015	.0090
5	9.9985	10.0035	.0050	10.0045	.0010	10.0075	.0030	10.0100	.0025	.0115
10	9.9995	10.0005	.0010	10.0030	.0025	10.0055	.0025	10.0045	—.0010	.0050
15	9.9990	9.9985	—.0005	10.0015	.0030	10.0030	.0015	10.0035	.0005	.0045
20	9.9990	9.9985	—.0005	9.9995	.0010	10.0015	.0020	10.0005	—.0010	.0015
25	9.9985	9.9985	.0000	10.0005	.0020	10.0015	.0010	10.0010	—.0005	.0025
30	9.9985	9.9985	.0000	10.0005	.0020	10.0025	.0020	10.0005	—.0020	.0020
35	9.9985	9.9995	.0010	10.0015	.0020	10.0045	.0030	10.0035	—.0010	.0050
40	9.9990	10.0005	.0015	10.0025	.0020	10.0045	.0020	10.0045	.0000	.0055
45	9.9985	9.9995	.0010	10.0015	.0020	10.0035	.0020	10.0025	—.0010	.0040
50	9.9990	10.0000	.0010	10.0025	.0025	10.0060	.0035	10.0035	—.0025	.0045
55	9.9990	10.0000	.0010	10.0025	.0025	10.0050	.0025	10.0035	—.0015	.0045
60	9.9985	9.9995	.0010	10.0025	.0030	10.0045	.0020	10.0035	—.0010	.0050
65	9.9085	9.9995	.0010	10.0025	.0030	10.0050	.0025	10.0055	.0005	.0070
70	9.9985	9.9995	.0010	10.0010	.0015	10.0050	.0040	10.0035	—.0015	.0050
75	9.9985	9.9995	.0010	10.0035	.0040	10.0065	.0030	10.0055	—.0010	.0070
80	9.9985	10.0005	.0020	10.0035	.0030	10.0060	.0025	10.0065	.0005	.0080
85	9.9985	10.0005	.0020	10.0030	.0025	10.0065	.0035	10.0055	—.0010	.0070
90	9.9985	10.0000	.0015	10.0045	.0045	10.0070	.0025	10.0075	.0005	.0090
95	9.9985	9.9995	.0010	10.0025	.0030	10.0060	.0035	10.0035	—.0025	.0050
100	9.9985	10.0005	.0020	10.0020	.0015	10.0065	.0045	10.0075	.0010	.0090
105	9.9985	10.0000	.0015	10.0040	.0040	10.0075	.0035	10.0075	.0000	.0090
110	9.9985	10.0005	.0020	10.0035	.0030	10.0075	.0040	10.0115	.0040	.0130
115	9.9985	10.0005	.0020	10.0065	.0060	10.0105	.0040	10.0085	—.0020	.0100
120	9.9985	10.0010	.0025	10.0055	.0045	10.0095	.0040	10.0115	.0020	.0130
125	9.9985	10.0010	.0025	10.0050	.0040	10.0095	0045	10.0115	.0020	.0130
130	9.9990	10.0010	.0020	10.0055	.0045	10.0095	.0040	10.0125	.0030	.0135
135	9.9990	10.0005	.0015	10.0055	.0050	10.0100	.0045	10.0085	—.0015	.0095
140	9.9990	10.0005	.0015	10.0030	.0025	10.0085	.0055	10.0140	.0055	.0150
145	9.9985	10.0010	.0025	10.0055	.0045	10.0105	.0050	10.0155	.0050	.0170
150	9.9985	10.0015	.0030	10.0075	.0060	10.0125	.0050	10.0195	.0070	.0210
155	9.9990	10.0020	.0030	10.0070	.0050	10.0135	.0065	10.0205	.0070	.0215
160	9.9985	10.0005	.0020	10.0055	.0050	10.0130	.0075	10.0215	.0085	.0230
165	9.9990	10.0015	.0025	10.0075	.0060	10.0160	.0085	10.0245	.0085	.0255
170	9.9985	10.0020	.0035	10.0085	.0065	10.0175	.0090	10.0305	.0130	.0320
175	9.9985	10.0015	.0030	10.0065	.0050	10.0190	.0125	10.0325	.0135	.0440
180	9.9990	10.0015	.0025	10.0085	.0070	10.0210	.0125	10.0375	.0165	.0385
185	9.9990	10.0025	.0035	10.0100	.0075	10.0235	.0135	10.0445	.0210	.0455
190	9.9990	10.0025	.0035	10.0105	.0080	10.0260	.0155	10.0520	.0260	.0530
195	9.9990	10.0035	.0045	10.0125	.0090	10.0305	.0180	10.0545	.0240	.0555
200	9.9990	10.0035	.0045	10.0145	.0110	10.0365	.0220	No contact after 195 inches.	No contact after 195 inches.	No contact after 195 inches.
202	9.9990	10.0045	.0055	10.0160	.0115	10.0385	.0225			
204	9.9990	10.0045	.0055	10.0155	.0110	10.0385	.0230			
206	9.9990	10.0045	.0055	10.0160	.0115	10.0405	.0245			
208	9.9990	10.0055	.0065	10.0175	.0120	10.0440	.0265			
210	9.9990	10.0060	.0070	10.0175	.0115	10.0435	.0260			
212	9.9990	10.0065	.0075	10.0185	.0120	10.0455	.0270			
214	9.9995	10.0075	.0080	10.0195	.0120	10.0455	.0260			
216	9.9995	10.0075	.0080	10.0215	.0140	10.0485	.0270			
218	9.9995	10.0085	.0090	10.0225	.0140	10.0520	.0295			
220	9.9990	10.0095	.0105	10.0240	.0145	10.0545	.0305			
222	9.9995	10.0105	.0110	10,0250	.0145	10.0555	.0305			
224	9.9095	10.0110	.0115	10.0265	.0155	10.0585	.0320			
226	9.9995	10.0115	.0120	10.0270	.0155	10.0645	.0375			
228	10.0000	10.0135	.0135	10.0295	.0160	10.0665	.0370			
230	10.0010	10.0155	.0145	10.0325	.0170	10.0705	.0380			
232	10.0050	10.0185	.0135	10.0360	.0175	10.0765	.0405			
234	10.0080	10.0225	.0145	10.0395	.0170	10.0785	.0390			
236	10.0115	10.0255	.0140	10.0445	.0190	10.0825	.0380			
238	10.0150	10.0285	.0135	10.0465	.0180	10.0865	.0400			
240	10.0185	10.0315	.0130	10.0505	.0190	10.0905	.0400			
242	10.0220	10.0345	.0125	10.0545	.0200	10.0965	.0420			
244	10.0245	10.0385	.0140	10.0585	.0200	10.1085	.0500			
246	10.0275	10.0425	.0150	10.0625	.0200	10.1205	.0580			
248	10.0305	10.0465	.0160	10.0685	.0220	10.1235	.0550			
250	10,0345	10.0515	.0170	10.0735	.0220	10.1320	.0585			
252	10.0380	10.0560	.0180	10.0815	.0255	10.1365	.0550			
254	10.0405	10.0595	.0190	10.0845	.0250	10.1405	.0560			
256	10.0435	10.0635	.0200	10.0910	.0275	10.1485	.0575			
258	10.0470	10.0690	.0220	10.0965	.0275	10.1595	.0630			
260	10.0500	10.0735	.0235	10.1040	.0305	10.1975	.0985			
262	10.0525	10.0795	.0270	10.1125	.0330	10.2040	.0915			
264	10.0550	10.0845	.0295	10.1185	.0340	10.1995	.0810			
266	10.0565	10.0895	.0330	10.1235	.0340	10.2095	.0860			
268	10.0585	10.0945	.0360	10.1315	.0370	10.2125	.0810			
268½	10.0600	10.0955	.0355	10.1320	.0365	10.2225	.0905			

Crozier design, Sandy Hook Proving Ground.

ants Peck and Wheeler, by Mr. G. Gerdom, jr.]

GROOVES.

[9.99845-inch ring and 10-inch points. Temperature: June 29, 1894, outside bore 75°, inside 80°; Aug. 27, 1894, outside bore 71°, inside 87°; June 14, 1895, outside bore 83°, inside 100°; Dec. 18, 1895, outside bore 40°, inside 40°.]

From muzzle.	Before firing, June 29, 1894.	After 67 rounds, Aug. 27, 1894.	Increase.	After 117 rounds, Feb. 25, 1895.	Increase.	After 188 rounds, June 14, 1895.	Increase.	After 275 rounds, Dec. 18, 1895.	Increase.	Total increase.
Inches.	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inch.*
0	10.1165	10.1205	.0040	10.1225	.0020	10.1245	.0020	10.1285	.0040	.0120
5	10.1195	10.1255	.0060	10.1260	.0005	10.1285	.0025	10.1315	.0030	.0120
10	10.1200	10.1225	.0025	10.1235	.0010	10.1260	.0025	10.1265	.0005	.0065
15	10.1200	10.1215	.0015	10.1215	.0000	10.1240	.0025	10.1255	.0015	.0055
20	10.1195	10.1205	.0010	10.1215	.0010	10.1240	.0025	10.1233	—.0005	.0040
25	10.1195	10.1205	.0010	10.1225	.0020	10.1260	.0035	10.1255	—.0005	.0060
30	10.1190	10.1205	.0015	10.1220	.0015	10.1230	.0010	10.1215	—.0015	.0025
35	10.1190	10.1205	.0015	10.1220	.0015	10.1245	.0025	10.1265	.0020	.0075
40	10.1185	10.1205	.0020	10.1215	.0010	10.1245	.0030	10.1265	.0020	.0080
45	10.1185	10.1205	.0020	10.1205	.0000	10.1245	.0040	10.1215	—.0030	.0030
50	10.1185	10.1205	.0020	10.1215	.0010	10.1250	.0035	10.1270	.0020	.0085
55	10.1185	10.1205	.0020	10.1215	.0010	10.1245	.0060	10.1245	.0000	.0060
60	10.1185	10.1210	.0025	10.1245	.0035	10.1205	.0050	10.1285	—.0010	.0100
65	10.1185	10.1210	.0025	10.1220	.0010	10.1235	.0015	10.1295	.0060	.0110
70	10.1185	10.1210	.0025	10.1215	.0005	10.1235	.0020	10.1315	.0080	.0130
75	10.1185	10.1210	.0025	10.1235	.0025	10.1245	.0010	10.1315	.0070	.0130
80	10.1185	10.1210	.0025	10.1235	.0025	10.1255	.0020	10.1325	.0070	.0140
85	10.1185	10.1210	.0025	10.1235	.0025	10.1260	.0025	10.1295	.0035	.0110
90	10.1185	10.1210	.0025	10.1235	.0025	10.1250	.0015	10.1295	.0045	.0110
95	10.1185	10.1210	.0025	10.1215	.0005	10.1265	.0050	10.1285	.0020	.0100
100	10.1190	10.1210	.0020	10.1235	.0025	10.1265	.0030	10.1295	.0030	.0105
105	10.1190	10.1215	.0025	10.1240	.0025	10.1285	.0045	10.1330	.0045	.0140
110	10.1185	10.1215	.0030	10.1255	.0040	10.1285	.0030	10.1315	.0030	.0130
115	10.1185	10.1220	.0035	10.1250	.0030	10.1305	.0055	10.1305	.0000	.0120
120	10.1185	10.1220	.0035	10.1265	.0045	10.1315	.0050	10.1265	—.0050	.0080
125	10.1185	10.1220	.0035	10.1265	.0045	10.1305	.0040	10.1295	—.0010	.0110
130	10.1185	10.1225	.0040	10.1265	.0040	10.1305	.0040	10.1335	.0030	.0150
135	10.1185	10.1225	.0040	10.1265	.0040	10.1305	.0040	10.1315	.0010	.0130
140	10.1185	10.1225	.0040	10.1255	.0030	10.1285	.0030	10.1315	.0030	.0130
145	10.1190	10.1230	.0040	10.1255	.0025	10.1320	.0065	10.1325	.0005	.0185
150	10.1185	10.1225	.0040	10.1280	.0055	10.1325	.0045	10.1325	.0000	.0140
155	10.1185	10.1225	.0040	10.1275	.0050	10.1325	.0050	10.1365	.0040	.0180
160	10.1190	10.1225	.0035	10.1255	.0030	10.1295	.0040	10.1400	.0005	.0110
165	10.1185	10.1235	.0050	10.1275	.0040	10.1345	.0070	10.1375	.0030	.0190
170	10.1185	10.1235	.0050	10.1285	.0050	10.1340	.0055	10.1455	.0115	.0270
175	10.1190	10.1235	.0045	10.1270	.0035	10.1355	.0085	10.1435	.0080	.0245
180	10.1195	10.1230	.0035	10.1270	.0040	10.1385	.0115	10.1485	.0100	.0290
185	10.1185	10.1225	.0040	10.1265	.0040	10.1385	.0120	10.1515	.0130	.0330
190	10.1185	10.1225	.0040	10.1265	.0040	10.1375	.0110	10.1515	.0140	.0330
195	10.1190	10.1235	.0045	10.1285	.0050	10.1415	.0130	10.1645	.0230	.0455
200	10.1195	10.1240	.0045	10.1305	.0065	10.1465	.0160	10.1665	.0200	.0470
202	10.1195	10.1235	.0040	10.1305	.0070	10.1465	.0160	10.1695	.0230	.0500
204	10.1185	10.1235	.0050	10.1315	.0080	10.1515	.0200	10.1685	.0170	.0500
206	10.1190	10.1235	.0045	10.1315	.0080	10.1510	.0195	10.1675	.0165	.0485
208	10.1185	10.1235	.0050	10.1315	.0080	10.1515	.0200	10.1705	.0190	.0520
210	10.1185	10.1235	.0050	10.1305	.0070	10.1515	.0210	10.1795	.0280	.0610
212	10.1185	10 1235	.0050	10.1305	.0070	10.1525	.0220	10.1745	.0220	.0560
214	10.1180	10.1230	.0050	10.1305	.0075	10.1505	.0200	10.1785	.0280	.0605
216	10.1180	10.1235	.0055	10.1325	.0090	10.1545	.0220	10.1765	.0220	.0585
218	10.1180	10.1235	.0055	10.1325	.0090	10.1525	.0200	10.1835	.0310	.0655
220	10.1180	10.1240	.0060	10.1335	.0095	10.1550	.0215	10.1985	.0435	.0805
222	10.1180	10.1245	.0065	10.1340	.0095	10.1565	.0225	10.1985	.0420	.0805
224	10.1180	10.1245	.0065	10.1345	.0100	10.1565	.0220	10.2005	.0440	.0825
226	10.1180	10.1245	.0065	10.1345	.0100	10.1605	.0260	10.2035	.0430	.0855
228	10.1180	10.1245	.0065	10.1365	.0120	10.1600	.0235	10.2085	.0485	.0905
230	10.1180	10.1245	.0065	10.1380	.0135	10.1650	.0270	10.2105	.0455	.0925
232	10.1180	10.1245	.0065	10.1375	.0130	10.1645	.0270	10.2185	.0490	.0955
234	10.1185	10.1245	.0060	10.1385	.0140	10.1655	.0270	10.2135	.0480	.0950
236	10.1180	10.1255	.0075	10.1380	.0125	10.1630	.0250	10.2105	.0475	.0925
238	10.1180	10.1255	.0075	10.1375	.0120	10.1695	.0320	No contact after 236 inches.	No contact after 236 inches.	No contact after 236 inches.
240	10.1180	10.1265	.0085	10.1410	.0145	10.1725	.0315			
242	10.1195	10.1265	.0070	10.1405	.0140	10.1765	.0360			
244	10.1195	10.1265	.0070	10.1435	.0170	10.1765	.0330			
246	10 1195	10.1265	.0070	10.1435	.0170	10.1805	.0370			
248	10.1195	10.1265	.0070	10.1455	.0190	10.1865	.0410			
250	10.1190	10.1265	.0075	10.1460	.0195	10.1915	.0455			
252	10.1190	10.1275	.0085	10.1475	.0200	10.1985	.0510			
254	10.1195	10.1295	.0100	10.1490	.0195	10.1975	.0485			
256	10 1195	10.1305	.0110	10.1505	.0200	10.2105	.0600			
258	10.1195	10 1320	.0125	10.1525	.0205	10.2085	.0560			
260	10.1195	10.1335	.0140	10.1555	.0220	10.2100	.0545			
262	10.1195	10.1355	.0160	10.1595	.0240	10.2130	.0535			
264	10.1195	10.1385	.0190	10.1615	.0230	10.2245	.0630			
266	10.1200	10.1405	.0205	10.1655	.0250	10.2245	.0590			
268	10.1195	10.1415	.0220	10.1685	.0270	10.2265	.0580			
268½	10.1200	10.1420	.0220	10.1685	.0265	10.2265	.0580			

Record of firing with 10-inch B. L. rifle, Crozier wire-wound (weight, 67,300

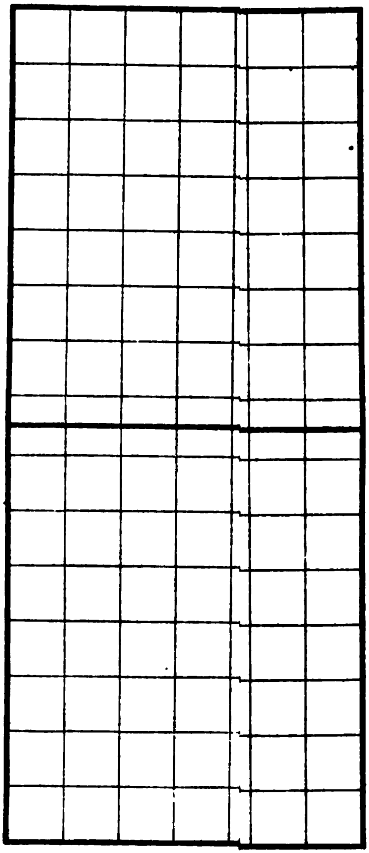
[Object of firing,

Date.	No. of fire.	Powder.				Projectile.		Shot marked.	Travel of shot in bore.	Elevation.		Instrumental velocity from muzzle.
		Kind.	Weight.		Number of prisms.	Kind.	Weight.					
1895.			*Lbs.*	*Oz.*			*Pounds.*		*Inches.*	°	'	*Feet.*
Oct. 24	240	Du Pont's brown prismatic, X. A., lot 3 A.	140	13½	1,482	Shot rebanded.	574	....	274.37	3	30	....
			141	13½	1,493							
				5	Igniter.							
			283	0								
Oct. 24	241		140	13½	1,482		574	....	274.37	3	30	....
			141	13½	1,493							
				5	Igniter.							
			283	0						*Depression.*		
Oct. 30	242	Du Pont's brown prismatic, X. A., lot 3 D.	140	13½	1,478	Shot, lot 537.	575	21	274.67		33	....
			141	13½	1,486							
				5	Igniter.							
			283	0								
Oct. 30	243		141	13½	1,489		579	22	274.77		33	....
			140	13½	1,479							
				5	Igniter.							
			283	0								
Oct. 30	244		141	13½	1,488		580	23	274.67		33	....
			140	13½	1,478							
				5	Igniter.							
			283	0								
Oct. 30	245		141	13½	1,492		580	24	274.97		37	....
			140	13½	1,472							
				5	Igniter.							
			283	0								
Oct. 30	246		141	13½	1,489		580	25	274.87		35	....
			140	13½	1,478							
				5	Igniter.							
			283	0								
Oct. 30	247		141	13½	1,489		577	26	274.77		35	....
			140	13½	1,478							
				5	Igniter.							
			283	0								
Oct. 30	248		141	13½	1,489		576	27	274.77		35	....
			140	13½	1,478							
				5	Igniter.							
			283	0								
Oct. 30	249		141	13½	1,490		577	28	274.67		35	....
			140	13½	1,479							
				5	Igniter.							
			283	0								
Oct. 30	250		141	13½	1,491		575	29	274.67		33	....
			140	13½	1,479							
				5	Igniter.							
			283	0								
Oct. 30	251		141	13½	1,491		576	30	274.67		32	....
			140	13½	1,479							
				5	Igniter.							
			283	0								

Plate I.

TARG*us Sight*

Number of shots fired, ...



● *Center of impact.* ....

● *Point aimed at.* ....

....

Tar

Appendix 27, 1896.

Ord 54 2

Record of firing with 10-inch B. L. rifle, Crozier wire-wound (weight, 67,300 pounds),

[Object of firing, for

Date.	No. of fire	Powder.			Projectile		Shot marked.	Elevation on wheel of sight.	Travel of shot in bore.	Elevation.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
1895			*Lbs. Oz.*			*Pounds.*		'	*Inches.*	° '
Nov. 11	257	Du Pont's brown prismatic, X. A., lot 3 D.	141 13½ 140 18½ 5 283 0	1,490 1,481 Igniter.	Shot, lot 537.	571	....	54	274.57	Quadrant. 1 28
Nov. 14	258		141 13½ 140 13½ 5 283 0	1,490 1,481 Igniter		578	....	58	274.97	Quadrant. 1 33
Nov. 18	259	Du Pont's brown prismatic, X. A., lot 3.	140 13½ 141 13½ 5 283 0	1,479 1,490 Igniter.		576	....	58	274.97	Quadrant. 1 33 Sight..... 1 10
Nov. 18	260		140 13½ 141 13½ 5 283 0	1,480 1,490 Igniter.		575	....	58	274.97	Quadrant. 1 33 Sight..... 1 10
Nov. 18	261		140 13½ 141 13½ 5 283 0	1,480 1,492 Igniter.		576	....	58	274.87	Quadrant. 1 33 Sight..... 1 10
Nov. 18	262		140 13½ 141 13½ 5 283 0	1,480 1,493 Igniter..		577	....	58	274 87	Quadrant 1 33 Sight..... 1 10
Nov. 19	263		140 13½ 141 13½ 5 283 0	1,482 1,495 Igniter.		578	....	58	274 77	Tel. sight. 1 20 Quadrant. 1 32
Nov. 19	264		140 13½ 141 13½ 5 283 0	1,485 1,495 Igniter.		576	....	58	274.97	Quadrant. 1 30½ Tel. sight. 1 20½
										Depression. '
Nov. 23	265		140 13½ 141 13½ 5 283 0	.... Igniter.		575	Not marked.	......	274.97	32
Nov. 23	266		140 13½ 141 13½ 5 283 0	.... Igniter.	Rebanded.	573	37	......	274.07	30

Watervliet Arsenal, at Sandy Hook Proving Ground, from November 14 to December 4, 1895.

accuracy at 1 mile.]

Deflection points, right.	Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
	Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			
0	O, less than 40,000 P, less than 40,000	6	4	6	0	Wind from left and front, 60°, 22 miles an hour; barometer, 30.43; thermometer, 51°; humidity, 81.	....	Fired at 1-mile target. Aimed at the upper left-hand corner of target.
0	H, 40,222 I, 40,178	6	4	6	4		....	
1	O, 40,333 P, 40,640	6	4½	6	4½	Wind from right, 90°, 10 miles an hour; barometer, 30.05, thermometer 60°; humidity, 50.	Struck target 6½ feet below, 1 foot right of center.	Gun mounted on 10-inch proof carriage. Obturating friction primers. Aimed at 1-mile target. Aimed by Scott sight No. 626 at the upper left-hand corner of target. Rod attached to front transom, holding elevating screw, straightened before firing, bent after first shot. The first countersunk bolt in rear on right side of under plate of top carriage found loose after round 262. Gun washed out and examined after each round. 40,000 coppers of 1893.
1	I, 41,867 K, 40,964	6	5	6	5	Wind from right, 90°, 14 miles an hour; barometer, 30 05; thermometer, 61°, humidity, 49.	Struck target 3 feet below, 2 feet right of center.	
1	O, 41,740 P, 43,036	6	5	6	5	Wind from right, 90°, 16 miles an hour; barometer, 30.05; thermometer, 60°; humidity, 48	Struck target 4 feet below center.	
1	I, 40,873 K, 40,436	6	5	6	3		Struck target 3 feet below, 2 feet left of center.	
1 4½	O, 40,244 P, 41,480	6	5	6	3	Wind from right, 90°. 4 miles an hour; barometer, 30.01; thermometer, 56°; humidity, 71.	Aimed by Scott telescopic sight at the upper right-hand corner; struck target 1 foot below, 4 feet right of center.	
3½	I, 40,127 K, 40,091	6	5	6	5	Wind from rear, 0°, 3 miles an hour; barometer, 30.02; thermometer, 53°; humidity, 75.	Struck target 8½ feet below, 7 feet right of center.	
......	O, 41,345 P, 41,420	6	4	6	4	Wind from rear, 8 miles an hour; barometer, 30.44; thermometer, 58°; humidity, 61.	....	Gun mounted on 10-inch proof carriage. Obturating friction primers. Fired into sand butt No. 1. 40,000 coppers of 1890.
......	O, 40,582 P, 40,680	6	4	6	0		Shot came out of butt and fell to the right.	

Record of firing with 10-inch B. L. rifle, Crozier wire-wound (weight, 67,300

[Object of firing, for

Date.	No. of fire.	Powder.				Projectile.		Shot marked.	Elevation on wheel of sight.	Travel of shot in bore.	Depression.
		Kind.	Weight.		No. of prisms.	Kind.	Weight.				
1895.			*Lbs.*	*Oz.*			*Pounds.*			*Inches.*	′
Nov. 23	267	Du Pont's brown prismatic, X. A., lot 3.	140 141 283	13½ 13½ 5 0	.... Igniter.	Solid shot. Lot 648.	578	38	....	274.07	25
Nov. 23	268		140 141 283	13½ 13½ 5 0	.... Igniter.	Lot 537.	575	39	....	274.67	24
Nov. 23	269		140 141 283	13½ 13½ 5 0	.... Igniter.		576	40	....	274.67	24
Nov. 23	270		140 141 283	13½ 13½ 5 0	.... Igniter.		576	41	....	274.67	24
											Elevation. ° ′
Dec. 4	271	Du Pont's brown prismatic, X. A., lot 3 C.	140 141 283	13½ 13½ 5 0	1,482 1,493 Igniter.	Solid shot, lot 537, large band.	576	....	....	274.87	Quadrant . 1 33 Sight..... 1 23
Dec. 4	272		140 141 283	13½ 13½ 5 0	1,478 1,489 Igniter.		575	....	....	274.77	Quadrant . 1 31 Sight..... 1 23
Dec. 4	273		140 141 283	13½ 13½ 5 0	1,478 1,489 Igniter.		576	....	....	274.77	Quadrant . 1 32½ Sight..... 1 23
Dec. 4	274		140 141 283	13½ 13½ 5 0	1,478 1,488 Igniter.		575	....	....	274.77	Quadrant . 1 32 Sight..... 1 23
Dec. 4	275		140 141 283	13½ 13½ 5 0	1,478 1,488 Igniter.		576	....	....	274.67	Quadrant . 1 32½ Sight..... 1 23

pounds), Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

accuracy at 1 mile.]

Deflection points, right.	Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	TARGET.								General remarks.
								From center of target.				From center of impact.				
								Vertical.		Horizontal.		Vertical.		Horizontal.		
								Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.	
	Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	
......	O, 41,145 P, 41,236	6	4	6	0	Wind from rear, 8 miles an hour; barometer, 30.44; thermometer, 58°; humidity, 61.	....									Gun mounted on 10-inch proof carriage. Obturating friction primers. Fired into sand butt No. 1. 40,000 coppers of 1890.
......	O, 41,364 P, 41,760	6	4	6	0		....									
......	O, less than 40,000 P, 40,333	6	4	6	0		....									
......	J, 40,350 K, 40,145	6	4	6	0		....									
1½	O, 40,055 P, 40,109	6	4	6	4	Wind from left and rear, 70°, 5 miles an hour; barometer, 30.37; thermometer, 29°; humidity, 66.		1	...	...	7	2.8	...	...	0.4	Gun mounted on 10 inch proof carriage. Obturating friction primers. Aimed by Scott sight No. 627 at the upper left-hand corner of 1-mile target. Gun washed out after each round. Center of impact: Feet. Below .... 1.8 Left .... 6.6 Mean vertical deviation from center of impact .... 1.84 Mean horizontal deviation from center of impact .... 0.64 Mean deviation from center of impact .... 1.95 Firing conducted by Lieut. W. S. Peirce, Ordnance Department, in the presence of the Ordnance Board. Present: Capt. F. Heath, Ordnance Department; Capt. W. Crozier, Ordnance Department. W. S. Peirce, Lieutenant, Ordnance Department, U. S. A. For the board: Frank H. Phipps, Major, Ordnance Department, U. S. A., president.
1½	O, 40,582 P, 40,311	6	4	6	4	Wind from left and rear, 45°, 4 miles an hour; barometer, 30.37; thermometer, 31°; humidity, 58.		0		...	5	1.8	...	1.6	...	
1½	O, 40,400 P, 40,400	6	4	6	4	Wind from rear, 5 miles an hour; barometer, 30.36; thermometer, 31°; humidity, 58.		...	3	...	7	...	1.2	...	.4	
1½	O, 40,182 P, 40,109	6	4	6	4			...	5	...	7	...	3.2	...	.4	
1½	O, 40,067 P, 40,178	6	4	6	4			...	2	...	7	...	.2	...	.4	

Star gauging of 10-inch B. L. rifle (steel), wire-wound,

[Gun star gauged, under the directions of Lieuten-

LANDS.

[9.99845-inch ring and 10-inch point. Temperature: June 29, 1894, outside bore 75°, inside 80°; August 27, 1894, outside bore 68°, inside 87°; June 14, 1895, outside bore 83°, inside 100°; December 18, 1895, outside bore 40°, inside 40°.]

From muzzle.	Before firing, June 29, 1894.	After 67 rounds, Aug. 27, 1894.	Increase.	After 117 rounds, Feb. 25, 1895.	Increase.	After 188 rounds, June 14, 1895.	Increase.	After 275 rounds, Dec. 18, 1895.	Increase.	Total increase.
Inches.	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inch.*
0	10.0010	10.0035	.0025	10.0035	.0000	10.0085	.0050	10.0100	.0015	.0090
5	9.9985	10.0035	.0050	10.0045	.0010	10.0075	.0030	10.0100	.0025	.0115
10	9.9995	10.0005	.0010	10.0030	.0025	10.0055	.0025	10.0045	—.0010	.0050
15	9.9990	9.9985	—.0005	10.0015	.0030	10.0030	.0015	10.0035	.0005	.0045
20	9.9990	9.9985	—.0005	9.9995	.0010	10.0015	.0020	10.0005	—.0010	.0015
25	9.9985	9.9985	.0000	10.0005	.0020	10.0015	.0010	10.0010	—.0005	.0025
30	9.9985	9.9985	.0000	10.0005	.0020	10.0025	.0020	10.0005	—.0020	.0020
35	9.9985	9.9995	.0010	10.0015	.0020	10.0045	.0030	10.0035	—.0010	.0050
40	9.9990	10.0005	.0015	10.0025	.0020	10.0045	.0020	10.0045	.0000	.0055
45	9.9985	9.9995	.0010	10.0015	.0020	10.0035	.0020	10.0025	—.0010	.0040
50	9.9990	10.0000	.0010	10.0025	.0025	10.0060	.0035	10.0035	—.0025	.0045
55	9.9990	10.0000	.0010	10.0025	.0025	10.0050	.0025	10.0035	—.0015	.0045
60	9.9985	9.9995	.0010	10.0025	.0030	10.0045	.0020	10.0035	—.0010	.0050
65	9.9985	9.9995	.0010	10.0025	.0030	10.0050	.0025	10.0055	.0005	.0070
70	9.9985	9.9995	.0010	10.0010	.0015	10.0050	.0040	10.0035	—.0015	.0050
75	9.9985	9.9995	.0010	10.0035	.0040	10.0065	.0030	10.0055	—.0010	.0070
80	9.9985	10.0005	.0020	10.0035	.0030	10.0060	.0025	10.0065	.0005	.0080
85	9.9985	10.0005	.0020	10.0030	.0025	10.0065	.0035	10.0055	—.0010	.0070
90	9.9985	10.0000	.0015	10.0045	.0045	10.0070	.0025	10.0075	.0005	.0090
95	9.9985	9.9995	.0010	10.0025	.0030	10.0060	.0035	10.0035	—.0025	.0050
100	9.9985	10.0005	.0020	10.0020	.0015	10.0065	.0045	10.0075	.0010	.0090
105	9.9985	10.0000	.0015	10.0040	.0040	10.0075	.0035	10.0075	.0000	.0090
110	9.9985	10.0005	.0020	10.0035	.0030	10.0075	.0040	10.0115	.0040	.0130
115	9.9985	10.0005	.0020	10.0065	.0060	10.0105	.0040	10.0085	—.0020	.0100
120	9.9985	10.0010	.0025	10.0055	.0045	10.0095	.0040	10.0115	.0020	.0130
125	9.9985	10.0010	.0025	10.0050	.0040	10.0095	0045	10.0115	.0020	.0130
130	9.9990	10.0010	.0020	10.0055	.0045	10.0095	.0040	10.0125	.0030	.0135
135	9.9990	10.0005	.0015	10.0055	.0050	10.0100	.0045	10.0085	—.0015	.0095
140	9.9990	10.0005	.0015	10.0030	.0025	10.0085	.0055	10.0140	.0055	.0150
145	9.9985	10.0010	.0025	10.0055	.0045	10.0105	.0050	10.0155	.0050	.0170
150	9.9985	10.0015	.0030	10.0075	.0060	10.0125	.0050	10.0195	.0070	.0210
155	9.9990	10.0020	.0030	10.0070	.0050	10.0135	.0065	10.0205	.0070	.0215
160	9.9985	10.0005	.0020	10.0055	.0050	10.0130	.0075	10.0215	.0085	.0230
165	9.9990	10.0015	.0025	10.0075	.0060	10.0160	.0085	10.0245	.0085	.0255
170	9.9985	10.0020	.0035	10.0085	.0065	10.0175	.0090	10.0305	.0130	.0320
175	9.9985	10.0015	.0030	10.0065	.0050	10.0190	.0125	10.0325	.0135	.0440
180	9.9990	10.0015	.0025	10.0085	.0070	10.0210	.0125	10.0375	.0165	.0385
185	9.9990	10.0025	.0035	10.0100	.0075	10.0235	.0135	10.0445	.0210	.0455
190	9.9990	10.0025	.0035	10.0105	.0080	10.0260	.0155	10.0520	.0260	.0530
195	9.9990	10.0035	.0045	10.0125	.0090	10.0305	.0180	10.0545	.0240	.0555
200	9.9990	10.0035	.0045	10.0145	.0110	10.0365	.0220	No contact after 195 inches.	No contact after 195 inches.	No contact after 195 inches.
202	9.9990	10.0045	.0055	10.0160	.0115	10.0385	.0225			
204	9.9990	10.0045	.0055	10.0155	.0110	10.0385	.0230			
206	9.9990	10.0045	.0055	10.0160	.0115	10.0405	.0245			
208	9.9990	10.0055	.0065	10.0175	.0120	10.0440	.0265			
210	9.9990	10.0060	.0070	10.0175	.0115	10.0435	.0260			
212	9.9990	10.0065	.0075	10.0185	.0120	10.0455	.0270			
214	9.9995	10.0075	.0080	10.0195	.0120	10.0455	.0260			
216	9.9995	10.0075	.0080	10.0215	.0140	10.0485	.0270			
218	9.9995	10.0085	.0090	10.0225	.0140	10.0520	.0295			
220	9.9990	10.0095	.0105	10.0240	.0145	10.0545	.0305			
222	9.9995	10.0105	.0110	10,0250	.0145	10.0555	.0305			
224	9.9995	10.0110	.0115	10.0265	.0155	10.0585	.0320			
226	9.9995	10.0115	.0120	10.0270	.0155	10.0645	.0375			
228	10.0000	10.0135	.0135	10.0295	.0160	10.0665	.0370			
230	10.0010	10.0155	.0145	10.0325	.0170	10.0705	.0380			
232	10.0050	10.0185	.0135	10.0360	.0175	10.0765	.0405			
234	10.0080	10.0225	.0145	10.0395	.0170	10.0785	.0390			
236	10.0115	10.0255	.0140	10.0445	.0190	10.0825	.0380			
238	10.0150	10.0285	.0135	10.0465	.0180	10.0865	.0400			
240	10.0185	10.0315	.0130	10.0505	.0190	10.0905	.0400			
242	10.0220	10.0345	.0125	10.0545	.0200	10.0965	.0420			
244	10.0245	10.0385	.0140	10.0585	.0200	10.1085	.0500			
246	10.0275	10.0425	.0150	10.0625	.0200	10.1205	.0580			
248	10.0305	10.0465	.0160	10.0685	.0220	10.1235	.0550			
250	10,0345	10.0515	.0170	10.0735	.0220	10.1320	.0585			
252	10.0380	10.0560	.0180	10.0815	.0255	10.1365	.0550			
254	10.0405	10.0595	.0190	10.0845	.0250	10.1405	.0560			
256	10.0435	10.0635	.0200	10.0910	.0275	10.1485	.0575			
258	10.0470	10.0690	.0220	10.0965	.0275	10.1595	.0630			
260	10.0500	10.0735	.0235	10.1040	.0305	10.1975	.0935			
262	10.0525	10.0795	.0270	10.1125	.0330	10.2040	.0915			
264	10.0550	10.0845	.0295	10.1185	.0340	10.1995	.0810			
266	10.0565	10.0895	.0330	10.1235	.0340	10.2095	.0860			
268	10.0585	10.0945	.0360	10.1315	.0370	10.2125	.0810			
268½	10.0600	10.0955	.0355	10.1320	.0365	10.2225	.0905			

Crozier design, Sandy Hook Proving Ground.

ants Peck and Wheeler, by Mr. G. Gerdom, jr.]

GROOVES.

[9.99845-inch ring and 10-inch points. Temperature: June 29, 1894, outside bore 75°, inside 80°; Aug. 27, 1894, outside bore 71°, inside 87°; June 14, 1895, outside bore 83°, inside 100°; Dec. 18, 1895, outside bore 40°, inside 40°.]

From muzzle.	Before firing, June 29, 1894.	After 67 rounds, Aug. 27, 1894.	Increase.	After 117 rounds, Feb. 25, 1895.	Increase.	After 188 rounds, June 14, 1895.	Increase.	After 275 rounds, Dec. 18, 1895.	Increase.	Total increase.
Inches.	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inch.*
0	10.1165	10.1205	.0040	10.1225	.0020	10.1245	.0020	10.1285	.0040	.0120
5	10.1195	10.1255	.0060	10.1260	.0005	10.1285	.0025	10.1315	.0030	.0120
10	10.1200	10.1225	.0025	10.1235	.0010	10.1260	.0025	10.1265	.0005	.0065
15	10.1200	10.1215	.0015	10.1215	.0000	10.1240	.0025	10.1255	.0015	.0055
20	10.1195	10.1205	.0010	10.1215	.0010	10.1240	.0025	10.1235	—.0005	.0040
25	10.1195	10.1205	.0010	10.1225	.0020	10.1260	.0035	10.1255	—.0005	.0060
30	10.1190	10.1205	.0015	10.1220	.0015	10.1230	.0010	10.1215	—.0015	.0025
35	10.1190	10.1205	.0015	10.1220	.0015	10.1245	.0025	10.1265	.0020	.0075
40	10.1185	10.1205	.0020	10.1215	.0010	10.1245	.0030	10.1265	.0020	.0080
45	10.1185	10.1205	.0020	10.1205	.0000	10.1245	.0040	10.1215	—.0030	.0030
50	10.1185	10.1205	.0020	10.1215	.0010	10.1250	.0035	10.1270	.0020	.0085
55	10.1185	10.1205	.0020	10.1215	.0010	10.1245	.0030	10.1245	.0000	.0060
60	10.1185	10.1210	.0025	10.1245	.0035	10.1295	.0050	10.1285	—.0010	.0100
65	10.1185	10.1210	.0025	10.1220	.0010	10.1235	.0015	10.1295	.0060	.0110
70	10.1185	10.1210	.0025	10.1215	.0005	10.1235	.0020	10.1315	.0080	.0130
75	10.1185	10.1210	.0025	10.1235	.0025	10.1245	.0010	10.1315	.0070	.0130
80	10.1185	10.1210	.0025	10.1235	.0025	10.1255	.0020	10.1325	.0070	.0140
85	10.1185	10.1210	.0025	10.1235	.0025	10.1260	.0025	10.1295	.0035	.0110
90	10.1185	10.1210	.0025	10.1235	.0025	10.1250	.0015	10.1295	.0045	.0110
95	10.1185	10.1210	.0025	10.1215	.0005	10.1265	.0050	10.1285	.0020	.0100
100	10.1190	10.1210	.0020	10.1235	.0025	10.1265	.0030	10.1295	.0030	.0105
105	10.1190	10.1215	.0025	10.1240	.0025	10.1285	.0045	10.1330	.0045	.0140
110	10.1185	10.1215	.0030	10.1255	.0040	10.1285	.0030	10.1315	.0030	.0130
115	10.1185	10.1220	.0035	10.1250	.0030	10.1305	.0055	10.1305	.0000	.0120
120	10.1185	10.1220	.0035	10.1265	.0045	10.1315	.0050	10.1265	—.0050	.0080
125	10.1185	10.1220	.0035	10.1265	.0045	10.1305	.0040	10.1295	—.0010	.0110
130	10.1185	10.1225	.0040	10.1265	.0040	10.1305	.0040	10.1335	.0030	.0150
135	10.1185	10.1225	.0040	10.1265	.0040	10.1305	.0040	10.1315	.0010	.0130
140	10.1185	10.1225	.0040	10.1255	.0030	10.1285	.0030	10.1315	.0030	.0130
145	10.1190	10.1230	.0040	10.1255	.0025	10.1320	.0065	10.1325	.0005	.0135
150	10.1185	10.1225	.0040	10.1280	.0055	10.1325	.0045	10.1325	.0000	.0140
155	10.1185	10.1225	.0040	10.1275	.0050	10.1325	.0050	10.1365	.0040	.0180
160	10.1190	10.1225	.0035	10.1255	.0030	10.1295	.0040	10.1400	.0005	.0110
165	10.1185	10.1235	.0050	10.1275	.0040	10.1345	.0070	10.1375	.0030	.0190
170	10.1185	10.1235	.0050	10.1285	.0050	10.1340	.0055	10.1455	.0115	.0270
175	10.1190	10.1235	.0045	10.1270	.0035	10.1355	.0085	10.1435	.0080	.0245
180	10.1195	10.1230	.0035	10.1270	.0040	10.1385	.0115	10.1485	.0100	.0290
185	10.1185	10.1225	.0040	10.1265	.0040	10.1385	.0120	10.1515	.0130	.0330
190	10.1185	10.1225	.0040	10.1265	.0040	10.1375	.0110	10.1515	.0140	.0330
195	10.1190	10.1235	.0045	10.1285	.0050	10.1415	.0130	10.1645	.0230	.0455
200	10.1195	10.1240	.0045	10.1305	.0065	10.1465	.0160	10.1665	.0200	.0470
202	10.1195	10.1235	.0040	10.1305	.0070	10.1465	.0160	10.1695	.0230	.0500
204	10.1185	10.1235	.0050	10.1315	.0080	10.1515	.0200	10.1685	.0170	.0500
206	10.1190	10.1235	.0045	10.1315	.0080	10.1510	.0195	10.1675	.0165	.0485
208	10.1185	10.1235	.0050	10.1315	.0080	10.1515	.0200	10.1705	.0190	.0520
210	10.1185	10.1235	.0050	10.1305	.0070	10.1515	.0210	10.1795	.0280	.0610
212	10.1185	10 1235	.0050	10.1305	.0070	10.1525	.0220	10.1745	.0220	.0560
214	10.1180	10.1230	.0050	10.1305	.0075	10.1505	.0200	10.1785	.0280	.0605
216	10.1180	10.1235	.0055	10.1325	.0090	10.1545	.0220	10.1765	.0220	.0585
218	10.1180	10.1235	.0055	10.1325	.0090	10.1525	.0200	10.1835	.0310	.0655
220	10.1180	10.1240	.0060	10.1335	.0095	10.1550	.0215	10.1985	.0435	.0805
222	10.1180	10.1245	.0065	10.1340	.0095	10.1565	.0225	10.1985	.0420	.0805
224	10.1180	10.1245	.0065	10.1345	.0100	10.1565	.0220	10.2005	.0440	.0825
226	10.1180	10.1245	.0065	10.1345	.0100	10.1605	.0260	10.2035	.0430	.0855
228	10.1180	10.1245	.0065	10.1365	.0120	10.1600	.0235	10.2085	.0485	.0905
230	10.1180	10.1245	.0065	10.1380	.0135	10.1650	.0270	10.2105	.0455	.0925
232	10.1180	10.1245	.0065	10.1375	.0130	10.1645	.0270	10.2135	.0490	.0955
234	10.1185	10.1245	.0060	10.1385	.0140	10.1655	.0270	10.2135	.0480	.0950
236	10.1180	10.1255	.0075	10.1380	.0125	10.1630	.0250	10.2105	.0475	.0925
238	10.1180	10.1255	.0075	10.1375	.0120	10.1695	.0320	No contact after 236 inches.	No contact after 236 inches.	No contact after 236 inches.
240	10.1180	10.1265	.0085	10.1410	.0145	10.1725	.0315			
242	10.1195	10.1265	.0070	10.1405	.0140	10.1765	.0360			
244	10.1195	10.1265	.0070	10.1435	.0170	10.1765	.0330			
246	10 1195	10.1265	.0070	10.1435	.0170	10.1805	.0370			
248	10.1195	10.1265	.0070	10.1455	.0190	10.1865	.0410			
250	10.1190	10.1265	.0075	10.1460	.0195	10.1915	.0455			
252	10.1190	10.1275	.0085	10.1475	.0200	10.1985	.0510			
254	10.1195	10.1295	.0100	10.1490	.0195	10.1975	.0485			
256	10 1195	10.1305	.0110	10.1505	.0200	10.2105	.0600			
258	10.1195	10 1320	.0125	10.1525	.0205	10.2085	.0560			
260	10.1195	10.1335	.0140	10.1555	.0220	10.2100	.0545			
262	10.1195	10.1355	.0160	10.1595	.0240	10.2130	.0535			
264	10.1195	10.1385	.0190	10.1615	.0230	10.2245	.0630			
266	10.1200	10.1405	.0205	10.1655	.0250	10.2245	.0590			
268	10.1195	10.1415	.0220	10.1685	.0270	10.2265	.0580			
268½	10.1200	10.1420	.0220	10.1685	.0265	10.2265	.0580			

Star gauging of 10-inch B. L. rifle (steel), wire-wound,

[Gun star gauged, under the directions of Lieuten-
LANDS.

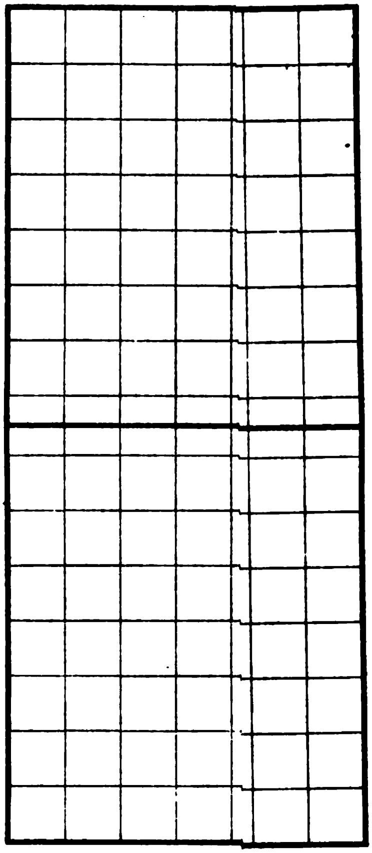
[9.99845-inch ring and 10-inch point. Temperature: June 29, 1894, outside bore 75°, inside 80°; August 27, 1894, outside bore 68°, inside 87°; June 14, 1895, outside bore 83°, inside 100°; December 18, 1895, outside bore 40°, inside 40°.]

From muzzle.	Before firing, June 29, 1894.	After 67 rounds, Aug. 27, 1894.	Increase.	After 117 rounds, Feb. 25, 1895.	Increase.	After 188 rounds, June 14, 1895.	Increase.	After 275 rounds, Dec. 18, 1895.	Increase.	Total increase.
Inches.	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inch.*
0	10.0010	10.0035	.0025	10.0035	.0000	10.0085	.0050	10.0100	.0015	.0090
5	9.9985	10.0035	.0050	10.0045	.0010	10.0075	.0030	10.0100	.0025	.0115
10	9.9995	10.0005	.0010	10.0030	.0025	10.0055	.0025	10.0045	—.0010	.0050
15	9.9990	9.9985	—.0005	10.0015	.0030	10.0030	.0015	10.0035	.0005	.0045
20	9.9990	9.9985	—.0005	9.9995	.0010	10.0015	.0020	10.0005	—.0010	.0015
25	9.9985	9.9985	.0000	10.0005	.0020	10.0015	.0010	10.0010	—.0005	.0025
30	9.9985	9.9985	.0000	10.0005	.0020	10.0025	.0020	10.0005	—.0020	.0020
35	9.9985	9.9995	.0010	10.0015	.0020	10.0045	.0030	10.0035	—.0010	.0050
40	9.9990	10.0005	.0015	10.0025	.0020	10.0045	.0020	10.0045	.0000	.0055
45	9.9985	9.9995	.0010	10.0015	.0020	10.0035	.0020	10.0025	—.0010	.0040
50	9.9990	10.0000	.0010	10.0025	.0025	10.0060	.0035	10.0035	—.0025	.0045
55	9.9990	10.0000	.0010	10.0025	.0025	10.0050	.0025	10.0035	—.0015	.0045
60	9.9985	9.9995	.0010	10.0025	.0030	10.0045	.0020	10.0035	—.0010	.0050
65	9.9985	9.9995	.0010	10.0025	.0030	10.0050	.0025	10.0055	.0005	.0070
70	9.9985	9.9995	.0010	10.0010	.0015	10.0050	.0040	10.0035	—.0015	.0050
75	9.9985	9.9995	.0010	10.0035	.0040	10.0065	.0030	10.0055	—.0010	.0070
80	9.9985	10.0005	.0020	10.0035	.0030	10.0060	.0025	10.0065	.0005	.0080
85	9.9985	10.0005	.0020	10.0030	.0025	10.0065	.0035	10.0055	—.0010	.0070
90	9.9985	10.0000	.0015	10.0045	.0045	10.0070	.0025	10.0075	.0005	.0090
95	9.9985	9.9995	.0010	10.0025	.0030	10.0060	.0035	10.0035	—.0025	.0050
100	9.9985	10.0005	.0020	10.0020	.0015	10.0065	.0045	10.0075	.0010	.0090
105	9.9985	10.0000	.0015	10.0040	.0040	10.0075	.0035	10.0075	.0000	.0090
110	9.9985	10.0005	.0020	10.0035	.0030	10.0075	.0040	10.0115	.0040	.0130
115	9.9085	10.0005	.0020	10.0065	.0060	10.0105	.0040	10.0085	—.0020	.0100
120	9.9985	10.0010	.0025	10.0055	.0045	10.0095	.0040	10.0115	.0020	.0130
125	9.9985	10.0010	.0025	10.0050	.0040	10.0095	0045	10.0115	.0020	.0130
130	9.9990	10.0010	.0020	10.0055	.0045	10.0095	.0040	10.0125	.0030	.0135
135	9.9990	10.0005	.0015	10.0055	.0050	10.0100	.0045	10.0085	—.0015	.0095
140	9.9990	10.0005	.0015	10.0030	.0025	10.0085	.0055	10.0140	.0055	.0150
145	9.9985	10.0010	.0025	10.0055	.0045	10.0105	.0050	10.0155	.0050	.0170
150	9.9985	10.0015	.0030	10.0075	.0060	10.0125	.0050	10.0195	.0070	.0210
155	9.9990	10.0020	.0030	10.0070	.0050	10.0135	.0065	10.0205	.0070	.0215
160	9.9985	10.0005	.0020	10.0055	.0050	10.0130	.0075	10.0215	.0085	.0230
165	9.9990	10.0015	.0025	10.0075	.0060	10.0160	.0085	10.0245	.0085	.0255
170	9.9985	10.0020	.0035	10.0085	.0065	10.0175	.0090	10.0305	.0130	.0320
175	9.9985	10.0015	.0030	10.0065	.0050	10.0190	.0125	10.0325	.0135	.0440
180	9.9990	10.0015	.0025	10.0085	.0070	10.0210	.0125	10.0375	.0165	.0385
185	9.9990	10.0025	.0035	10.0100	.0075	10.0235	.0135	10.0445	.0210	.0455
190	9.9990	10.0025	.0035	10.0105	.0080	10.0260	.0155	10.0520	.0260	.0530
195	9.9990	10.0035	.0045	10.0125	.0090	10.0305	.0180	10.0545	.0240	.0555
200	9.9990	10.0035	.0045	10.0145	.0110	10.0365	.0220			
202	9.9990	10.0045	.0055	10.0160	.0115	10.0385	.0225	No contact after 195 inches.	No contact after 195 inches.	No contact after 195 inches.
204	9.9990	10.0045	.0055	10.0155	.0110	10.0385	.0230			
206	9.9990	10.0045	.0055	10.0160	.0115	10.0405	.0245			
208	9.9990	10.0055	.0065	10.0175	.0120	10.0440	.0265			
210	9.9990	10.0060	.0070	10.0175	.0115	10.0435	.0260			
212	9.9990	10.0065	.0075	10.0185	.0120	10.0455	.0270			
214	9.9995	10.0075	.0080	10.0195	.0120	10.0455	.0260			
216	9.9995	10.0075	.0080	10.0215	.0140	10.0485	.0270			
218	9.9995	10.0085	.0090	10.0225	.0140	10.0520	.0295			
220	9.9990	10.0095	.0105	10.0240	.0145	10.0545	.0305			
222	9.9995	10.0105	.0110	10,0250	.0145	10.0555	.0305			
224	9.9995	10.0110	.0115	10.0265	.0155	10.0585	.0320			
226	9.9995	10.0115	.0120	10.0270	.0155	10.0645	.0375			
228	10.0000	10.0135	.0135	10.0295	.0160	10.0665	.0370			
230	10.0010	10.0155	.0145	10.0325	.0170	10.0705	.0380			
232	10.0050	10.0185	.0185	10.0360	.0175	10.0765	.0405			
234	10.0080	10.0225	.0145	10.0395	.0170	10.0785	.0390			
236	10.0115	10.0255	.0140	10.0445	.0190	10.0825	.0380			
238	10.0150	10.0285	.0135	10.0465	.0180	10.0865	.0400			
240	10.0185	10.0315	.0130	10.0505	.0190	10.0905	.0400			
242	10.0220	10.0345	.0125	10.0545	.0200	10.0965	.0420			
244	10.0245	10.0385	.0140	10.0585	.0200	10.1085	.0500			
246	10.0275	10.0425	.0150	10.0625	.0200	10.1205	.0580			
248	10.0305	10.0465	.0160	10.0685	.0220	10.1235	.0550			
250	10,0345	10.0515	.0170	10.0735	.0220	10.1320	.0585			
252	10.0380	10.0560	.0180	10.0815	.0255	10.1365	.0550			
254	10.0405	10.0595	.0190	10.0845	.0250	10.1405	.0560			
256	10.0435	10.0635	.0200	10.0910	.0275	10.1485	.0575			
258	10.0470	10.0690	.0220	10.0965	.0275	10.1595	.0630			
260	10.0500	10.0735	.0235	10.1040	.0305	10.1975	.0935			
262	10.0525	10.0795	.0270	10.1125	.0330	10.2040	.0915			
264	10.0550	10.0845	.0295	10.1185	.0340	10.1995	.0810			
266	10.0565	10.0895	.0330	10.1235	.0340	10.2095	.0860			
268	10.0585	10.0945	.0360	10.1315	.0370	10.2125	.0810			
268½	10.0600	10.0955	.0355	10.1320	.0365	10.2225	.0905			

Plate I.

TARG[illegible] *Sight*

Number of shots fired.



● *Center of impact.*

● *Point aimed at.*

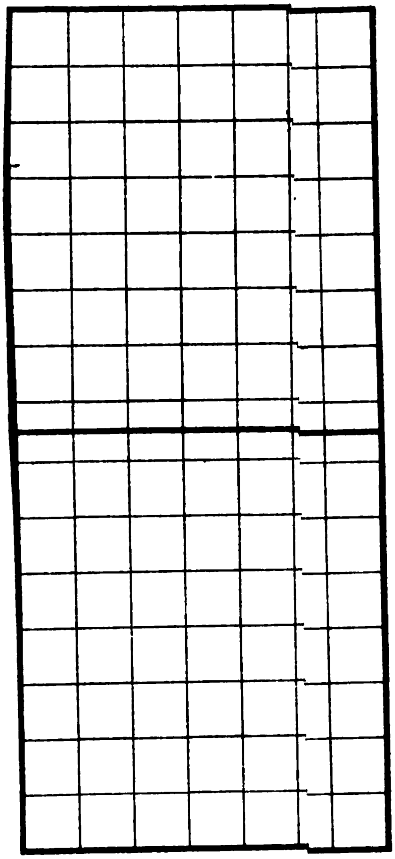
Tar

Appendix 27, 1896.

Plate II

TARGET *for Y Azimuth Circle.*

Number of shots fired, *8*



● ***Center of impact.***

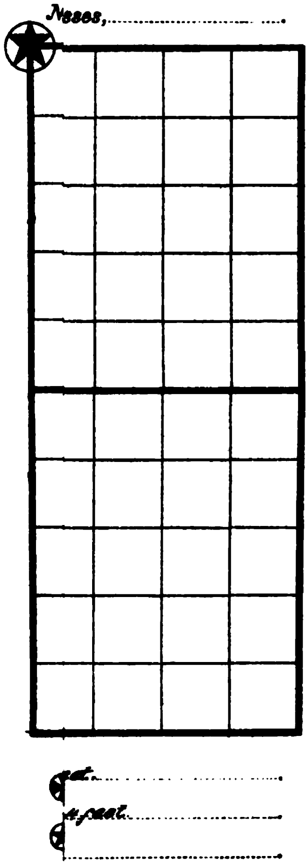
⊛ ***Point aimed at.***

Target 30

Appendix 27, 1896.

Plate III.

I. J. Dec. 4th 1895.

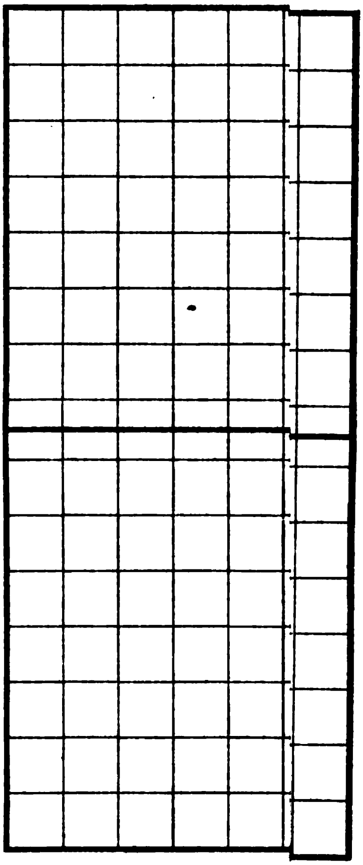


Appendix 27, 1896.

Plate IV.

TARGET

Number of shots fired, 12.



⊛ *Center of impact.*

⊛ *Point aimed at.*

Target 30'

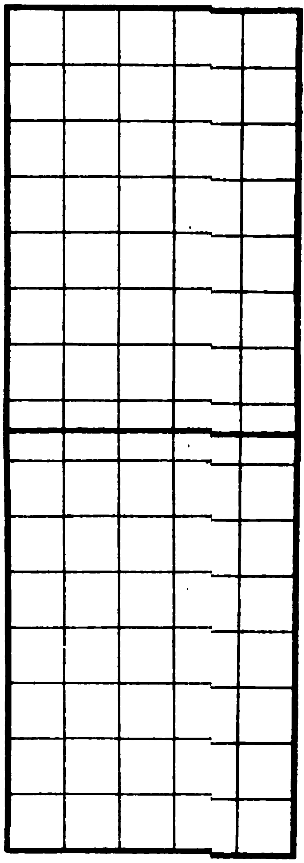
Appendix 27, 1896.

Ord 54 2

Plate V.

TAR

Number of shots fired..............



● *Center of impact.* ....

● *Point aimed at.* ....

Appendix 27, 1896.

Ord 54 2

Plate VI.

TA

Number of shots fi

⊛ *Center of impact.*

⊛ *Point aimed at.*

Appendix 27, 1896.

APPENDIX 28.

TRIAL OF 10-INCH B. L. RIFLE, STEEL, TYPE.

(2 plates.)

SANDY HOOK PROVING GROUND,
February 11, 1896.

Report of the test of the 10-inch B. L. rifle, steel, No. 1, Watervliet Arsenal, N. Y., made by the Board for Testing Rifled Cannon, appointed under the act of Congress approved July 5, 1884.

The 10-inch B. L. rifle, steel, No. 1, was turned over to the Board at the Sandy Hook Proving Ground, Sandy Hook, N. J., for test in compliance with instructions of the Chief of Ordnance, U. S. A., dated November 30, 1892.

DESCRIPTION.

The description of this piece is omitted, as it has already been fully described in the Report of the Chief of Ordnance, 1890, page 241. Previous to its having been put into the hands of the Board, this gun had been fired 177 rounds with pressures ranging as follows: Six rounds of 16,000 pounds per square inch or less, 16 between 16,000 and 24,000 pounds, 27 between 24,000 and 30,000 pounds, 36 between 30,000 and 35,000 pounds, 49 between 35,000 and 38,000 pounds, 21 over 38,000 pounds, and 22 not taken.

Of the 22 rounds for which no pressures are recorded, 11 were fired with charges of 240 pounds and over, and may therefore be considered as having given pressures between 35,000 and 38,000 pounds, i. e., service pressures. On this assumption, the gun had therefore been fired 81 rounds with pressures above 35,000 pounds per square inch.

MOUNTS.

The mounts used in the test of the 10-inch rifle, together with the total number of rounds fired from each, are as follows:

	Rounds.
Experimental carriage for 8-inch and 10-inch rifles	58
Pneumatic disappearing carriage	78
10-inch proof carriage	81
Gordon disappearing carriage (first)	33
10-inch service barbette carriage	42
Total	292

Of these all except the 10-inch proof and the 10-inch service barbette carriages were experimental mounts. The alterations and repairs required for the latter interrupted the test of the gun and were the cause of several vexatious delays.

TEST.

The Board adopted the following programme for the test of this gun:

TEST FOR ACCURACY.

That 15 rounds be fired, in groups of 5 each, at the 3,000-yard target and 10 rounds in groups of 5 each be fired at the 1-mile target for accuracy.

TEST FOR RANGE.

That three groups of 5 rounds each be fired for range and accuracy with three different elevations, including the maximum obtainable on the carriage on which the gun is mounted.

ENDURANCE.

The gun to be fired a sufficient number of rounds to complete 300 in all, using a charge of about 250 pounds of powder, a projectile weighing about 575 pounds, to give a muzzle velocity of about 1,975 feet per second, and a maximum pressure not to exceed 37,000 pounds per square inch. Pressures and velocities to be taken and the gun to be star gauged and impressions made as often as the Board may deem necessary.

TEST FOR RAPIDITY.

That one or more groups of 10 rounds each be fired for rapidity, all facilities being used to overcome unnecessary delays in firing.

As stated previously, 177 rounds had already been fired before the piece was placed in the hands of the Board. Of these rounds a large number had been fired in the effort to obtain a suitable powder for the test of the gun. With this powder test there had also been united a partial test of the accuracy of the piece. Three groups of rounds were fired at the 1-mile target, one group of 8 rounds, one of 2 rounds, and one of 5 rounds.

To complete the programme of the Board, therefore, there remained to be fired 123 rounds with projectiles weighing 575 pounds and charges giving 37,000 pounds pressure per square inch.

Of these rounds 15 were to be fired in groups of 5 each at the 3,000-yard target; 15 in groups of 5 each with three different elevations, including the maximum elevation attainable; and at least one group of 10 rounds for rapidity.

This balance of the programme has not been entirely carried out. After the two hundred and ninety-second round it was found that erosion of the bore in the vicinity of the seat of the projectile had progressed to such an extent as to practically destroy the accuracy of fire. The gun having thus become unserviceable, it was considered that further firing would not only be of little value, but would also render the desirable operation of relining the tube more difficult, if not altogether impossible. The test was accordingly concluded at this point.

The conclusion of the test left the following items of the programme uncompleted, viz:

One group of 5 rounds at the 3,000-yard target for accuracy.
One group of 10 rounds for rapidity.

A record of all firings made with this gun, with explanatory notes and remarks, accompanies this report.

POWDER.

The requirements of the powder for the 10-inch B. L. rifle, steel, are as follows:

Kind of powder: V. U. brown prismatic.

Charge	pounds..	250
Pressure per square inch	do	37,000
Initial velocity	feet per second..	1,975

The table given below shows the different powders used in this gun and the number of rounds fired with each.

Table of powders.

Kind of powder.	Number of rounds.	Kind of powder.	Number of rounds.
German brown prismatic	9	Du Pont's brown prismatic—Cont'd.	
Du Pont's brown prismatic:		V. U., lot 7	60
N. V., lot 7	15	V. U., lot 8	2
V. D	3	V. U., lot 9	11
U. G	4	V. U., lot 10	3
U. H	4	V. U., lot 14	2
V. O	3	V. U., lot 15	2
V. R	4	V. U., lot 16	6
V. S	3	V. U., lot 17	2
U. V	4	V. U., lot 19	29
U. T	2	V. U., lot 22	24
V. U., lot 1	35	V. P., lot 14	4
V. U., lot 2	24	W. H., lot 4	17
V. U., lot 3	6	German smokeless for 8-inch rifle	2
V. U., lot 4	3	French smokeless, B. N	4
V. U., lot 5	2		
V. U., lot 6	3	Total	292

PROJECTILES.

The projectiles used were mainly cast-iron shot. A few rounds have been fired with armor-piercing shot. The weights were 571 pounds and 575 pounds. The first 58 rounds were fired with 571-pound projectiles, the remaining 234 rounds with 575-pound projectiles.

ENDURANCE.

THE GUN.

This gun has endured 292 rounds without any apparent loss of strength. Of this number 144 have given pressures above 35,000 pounds per square inch. The maximum pressure obtained was 62,600 pounds per square inch. The erosion of the tube at, and for some distance in front of, the seat of the projectile is now so great as to destroy the accuracy of fire, and for that reason alone the gun is considered unserviceable. The progress of this erosion is shown in the series of impressions which accompany this report. As was to be expected, the erosion increased very rapidly toward the last.

Up to about the two hundredth round the accuracy of the piece was not materially affected by this erosive action. Soon after this, however, it was found that projectiles with the service band did not take the rifling well enough to insure accurate flight. At the two hundred and eighteenth round a projectile was used having a band in form the same as the service band, but of one-tenth inch greater diameter. The effect of these larger bands was noticeable at once. The accuracy of fire was restored and the gun again rendered serviceable.

After the two hundred and fiftieth round the erosion had progressed so far as to make necessary further increase in diameter of band.

This second increase brought the extreme diameter of the band up to 10.425 inches and produced results as satisfactory as those obtained by the first increase. At the two hundred and eighty-eighth round, however, this advantage disappeared.

Out of five shots at the 3,000-yard target but two hits were obtained, as against a record of five hits at the same range with the five shots immediately preceding. As the travel of the shot had not materially decreased it was not thought that the difficulty could be overcome, as in previous instances, by an additional increase in thickness of band.

From an inspection of the extent of the eroded portion of the bore, it seems probable that the velocity acquired by the shot before reaching the uninjured portion of the rifling is sufficient to partially shear or tear the band, so that the full velocity of rotation is not imparted.

BREECH MECHANISM.

Considerable trouble was experienced with the gas-check cups originally used with this gun. As in the case of the 12-inch mortar, steel, all difficulty of this kind disappeared after the substitution of steel split rings for the cups.

At the one hundred and ninety-ninth round the spindle broke at the front thread, the threaded portion, together with the nuts, being projected some distance to the rear. The pressure recorded for this round was 59,900 pounds per square inch. As the fracture indicated good metal, it could only be concluded that the sectional area, combined with the influence of the sharp reentrant angle of the V thread used, was not sufficient to withstand the strain. A new spindle was accordingly made, in which the diameter of the unthreaded part was increased and a fillet turned at the forward end of the threaded part.

This new spindle endured only 18 rounds, breaking at a point between the obturator nut and the locking nut. The pressure was 62,600 pounds per square inch. A second spindle was then made similar to the last except that the diameter of the threaded parts was also increased and a fillet placed between the right and left hand threads. This spindle lasted during the remainder of the test and is still apparently uninjured.

After the two hundred and thirty-seventh round the breechblock could not at first be rotated. Considerable power was applied to the rotating crank, but with no effect. It was finally rotated by striking the translating stud with a drift and sledge. The block could not then be withdrawn by the translating roller. Upon removing the face plate two teeth were found broken in pinion No. 3. The pressure for this round was only 35,800 pounds per square inch, so that it is difficult to find a reasonable explanation for this accident. No recurrence of this action has since been encountered. A new pinion was made and used in all rounds thereafter.

Some difficulty was also caused by the tray latch failing to hold the tray firmly against the breech plate while the block is being run in. When this occurs the tray latch spring bolt rises and its upper end is pressed forcibly against the translating roller, the sharp edges of which cut and deform the bolt. The effect of this action is to make translation of the block very difficult.

In other 10-inch guns of the same model this trouble has been practically overcome by rounding the edges of the threads of the roller and by the addition of a shoe on the end of the spring bolt.

ACCURACY.

In accordance with the programme several targets have been made at different ranges and elevations. A plot of each target with required data accompanies this report. Taking into consideration the condition of the bore at the times the different targets were made, the accuracy of this gun is regarded as satisfactory.

RAPIDITY.

The test for rapidity of fire of this type 10-inch gun was not completed at the time when firing was discontinued. As the Board, however, has official knowledge that other 10-inch guns of like model have been fired for rapidity ten rounds in 14 minutes 41 9-10 seconds from a disappearing carriage, and in 14 minutes 39 seconds from a barbette carriage, it therefore considers that the type gun would fully comply with all requirements in this direction.

STAR GAUGING.

This gun has been star gauged as follows:

Before firing, September 16, 1890.
After 64 rounds, February 23, 1892.
After 130 rounds, July 21, 1892.
After 190 rounds, May 19, 1893.
After 217 rounds, April 26, 1894.
After 244 rounds, June 18, 1895.
After 292 rounds, February 8, 1896.

The records of these star gaugings, showing the successive and the total increase in diameters, are appended hereto.

CONCLUSIONS.

This gun has successfully withstood 292 rounds. As the result of this test no injury except that due to the erosive effects of the powder gases can be detected. This erosion has destroyed the accuracy of fire, and for this reason alone the gun in its present condition is considered unserviceable.

The 10-inch B. L. rifle, steel, No. 1, has been subjected to the proper test for the determination of the endurance of the same, and the Board therefore concludes that the 10 inch B. L. rifle, steel, is a suitable gun "to be put in the Government service."

In view of the otherwise good condition of this gun, the Board is of the opinion that it is desirable to have it relined, if possible, and then submitted to further test.

ISAAC ARNOLD, JR.,
Major, Ordnance Department, U. S. A., President.
FRANK H. PHIPPS,
Major, Ordnance Department, U. S. A.
J. W. REILLY,
Major, Ordnance Department, U. S. A.
FRANK HEATH,
Captain, Ordnance Department, U. S. A.
W. S. PEIRCE,
Lieutenant, Ordnance Department, U. S. A., Recorder.

(14179)

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal,

[Object of firing, to

Date.	No. of fire.	Powder.			Projectile.				Travel of shot in bore.	Depression.	Instrumental velocity, feet.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.					
1890.			*Pounds.*			*Lbs.*	*Oz.*		*Inches*	′	*175 feet from muzzle.*
Sept. 16	1	German brown prismatic.	45	452	Cored shot, band "A," lot 255.	568	0		255.05	20	1,584
			130	1,297+7		3	0	sand.			1,584
			175			571	0				
Sept. 16	2		70	702		570	0		255.25	18	1,687
			130	1,296+7		1	0	sand.			1,687
			200			571	0				100+1½°
Sept. 17	3		95	951		569	0		255.25	18	1,784
			130	1,296+7		2	0	sand.			1,781
			225			571	0				

at Sandy Hook Proving Ground, from September 16, 1890, to April 25, 1892.

test gun for endurance.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			Gun star gauged before firing September 16, 1890, by Lieut. W. W. Gibson, Ordnance Department. Gun mounted on experimental carriage for 8-inch and 10-inch rifles; cylinders of carriage fitted with steel obturating bars. Carriage run from battery before filling cylinders. Depth of oil in right cylinder measured 4⅝ inches at filling hole. Depth of oil in left cylinder measured 4⅜ inches at filling hole. Cartridge bag cut. Obturating electric primers (improved), received March 24, 1890. Fired into new butt, section 3. Pressure gauges in a vertical line, C above, D below. Copper cylinders of 18,000 pounds initial compression and tables of 1887. Loading pan turned during ramming of shot, due to its loose fit in breech recess, and studs on pan caught on threads of recess. Diameter of loading pan too small to permit insertion of cartridge in chamber without difficulty. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department. Firing (rounds 1 and 2) conducted by the proof officer.
C, 24,540 D, 23,950	4	4½	4	3½	Wind from right and front, 9 miles an hour.	....	
C, 27,700 D, 27,500	4	4½	4	4½		Obturator seat wiped out with moist waste and oiled. After this round gun was reloaded with 225 pounds of powder—front cartridge 95 pounds and rear cartridge 130 pounds—and a projectile weighing 571 pounds and prepared for firing. 3 electric primers and 1 friction primer fired, all of which failed to ignite charge. The breech was then opened and the bag and powder found blackened. Cartridge had been pushed too far into chamber to be ignited by primer and could not be withdrawn. Rear cartridge broken in removing it from gun. Front cartridge then removed and shot left in gun. Firing suspended.	
C, 31,180 D, 31,250	4	3	3	9	Wind from left, 11 miles an hour.	Front cartridge same as loaded after round 2 previous firing, second cartridge replaced by a fresh one. Wide openings in base of cartridge between prisms due to forcing cartridge through loading pan. Slide of first velocity frame blown out by blast. First velocity frame moved back 20 feet. Copper cylinders of 28,000 pounds initial compression and tables of 1887. After this round joint between hoops C 7 and C 8 found opened slightly on right side, and hoop C 9 moved slightly over tube at muzzle.	Gun mounted on experimental carriage for 8-inch and 10-inch rifles. Cylinders of carriage fitted with steel obturating bars. Obturating electric primers (improved), received March 24, 1890. Pressure gauges in a vertical line, C above, D below. Fired into new butt, section 3. Loading pan turned

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal, at Sandy

[Object of firing, to

Date.	No. of fire.	Powder.			Projectile.		Travel of shot in bore.	Depression.	Instrumental velocity, feet.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.			
1890.			*Pounds.*			*Lbs. Oz.*	*Inches.*	′	*175 feet from muzzle.*
Sept. 17	4	German brown prismatic.	100 135 235	1,003 1,347+7	Cored shot, band "A," lot 255.	564 0 3 0 sand. 4 0 lead. 571 0	255.05	18	1,826 1,825
Sept. 17	5		110 135 245	1,103 1,348+7		567 0 4 0 sand. 571 0	255.05	18	1,864 1,873
									195 feet from muzzle.
Sept. 17	6		125 130 255	1,253 1,297+7		565 0 4 0 lead. 2 0 sand. 571 0	255.25	18	1,941 1,947 120+[illegible]
1891. Mar. 24	7		110 135 245	1,103 1,348+7		571 0 natural weight.	255.25	18	1,898 1,895

Hook Proving Ground, from September 16, 1890, to April 25, 1892—Continued.

test gun for endurance.]

Pressure per square inch of bore.	Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft. In.*	*Ft. In.*			
C, 34,000 D, 33,480	4 3	3 3	Wind from left, 11 miles an hour.	Wide openings in base of cartridge between prisms, due to forcing cartridge through loading pan. Slide of first velocity frame blown down, due to spreading of upright. Connection pipe between the two cylinders leaking on right side. Copper cylinders of 32,000 pounds initial compression and tables of 1890. After this round connecting strips nailed across uprights of first velocity frame to prevent spreading.	during ramming of shot, due to its loose fit in breech recess, and studs on pan caught on threads of recess. Diameter of loading pan too small to permit insertion of cartridge in chamber without difficulty. Pressure gauges in a vertical line, C above, D below. Copper cylinders of 32,000 pounds initial compression and tables of 1887. Fired into new butt, section 3. Loading pan was slipped over cartridge before inserting cartridge in breech. Breech mechanism worked with perfect ease throughout the firing. Obturation good. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
C, 34,740 D, 34,240	4 3½	2 1		After this round third bolt from front end of each cylinder attaching obturating bars to cylinders broken off. Loading pan was slipped over cartridge before inserting cartridge in breech.	
C, 37,860 D, 36,710	3 1	......		Before this round an iron bar was wedged under chassis rail across tops of cylinders to hold down broken bolts in cylinders and prevent leakage. Second bolt from front end of right cylinder, and first and second bolts from front end of left cylinder broken off. Right chassis rail bent for a distance of about 20 inches. Maximum ordinate of bend $\frac{7}{16}$ inch and 34 inches from front buffers. Right chassis rail cracked open for a distance of about 18 inches along bend. Left chassis rail bent slightly. Lip of right front guide cracked open at front end about ½ inch.	
C, 36,600 D, 36,440	5 0	5 0	....	Carriage 1½ inches out of battery when gun was fired. Leakage of oil around bolts of throttling bars and at rear end of cylinders. Hook on left yoke plate cracked. Copper cylinders of 32,000 pounds initial compression and tables of 1890.	Since last firing chassis rails increased in thickness, additional throttling bar placed in each cylinder, piston rods prolonged through rear end of cylinders, and packing plates put under yokes of carriage. Fired into sand butt No. 2. Cylinders filled with gun in battery. Left cylinder 11¾ gallons of oil, full to bottom of filling hole. Impossible to measure depth on account of piston rod. Same amount of oil in right cylinder. Loading pan slipped over cartridge before inserting cartridge in breech. Obturating electric primers, April 29, 1890. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal, at Sandy

[Object of firing, to

Date.	No. of fire.	Powder.			Projectile.			Travel of shot in bore.	Depression.	Instrumental velocity, feet.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
1891.			*Pounds.*			*Lbs.*	*Oz.*	*Inches.*		*175 feet from muzzle.*
Mar. 26	8	German brown prismatic.	110 125 235	1, 098 1, 347+5	Cored shot, band "A," lot 255.	566 5 571	0 0 sand. 0	255. 25	18	1, 885 1, 875
Mar. 30	9		125 130 255	....		566 5 571	0 0 sand. 0	255. 15	20	1, 918 1, 911
Apr. 6	10	Du Pont's brown prismatic, N. V., lot 7; density, 1.830.	40 135 175	430 1, 447 +5		571	0	255. 25	18	1, 670 1, 654
Apr. 6	11		55 135 190	591 1, 447+5		569 1 571	8 8 sand. 0	255. 25	18	1, 676 Lost.
Apr. 6	12		75 135 210	807 1, 447+5		569 2 571	0 0 sand. 0	255. 25	18	1, 795 1, 809
Apr. 6	13		65 135 200	699 1, 447+5		569 2 571	0 0 sand. 0	255. 25	12	1, 728 1, 731
Apr. 6	14		70 135 205	753 1, 447+5		566 5 571	0 0 sand. 0	255. 25	12	1, 703 Lost. $100+\frac{159}{2}$

Hook Proving Ground, from September 16, 1890, to April 25, 1892—Continued.

test gun for endurance.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General Remarks.
Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			
C, 35,800 D, 35,600	5	3	5	3	....	Breechblock closed easily. Crack in hook in left yoke plate increased. Oil escaped through rear stuffing boxes of both cylinders. Slight escape at plug in filling hole right cylinder and slight escape at fourth top tap bolt. Copper cylinders of 32,000 pounds initial compression and tables of 1890.	Obturating electric primers, April 29, 1890. Fired into sand butt, section 3. Loading pan was slipped over cartridge before inserting cartridge in breech. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
C, 36,905 D, 36,935	5	1	5	1	....	Carriage ¾ inch out of battery when gun was fired. Oil escaped through rear stuffing box of each cylinder.	1 pint of oil added to cylinder. Obturating electric primers. Fired into sand butt, section 3. Loading pan was slipped over cartridge before inserting cartridge in breech. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
C, 33,570 D, 34,900	4	9	4	9	....	Carriage 1 inch out of battery when gun was fired. Oil escaped at filling hole. Right cylinder stuffing boxes tightened after this round. Copper cylinders of 18,000 pounds initial compression and tables of 1890 used in gauge C. Copper cylinders of 24,000 pounds initial compression and tables of 1887 used in gauge D.	Gun mounted on experimental carriage for 8-inch and 10-inch rifle. Cylinder of carriage fitted with steel obturating bars. 1 quart of oil added to cylinder. Obturating electric primers, April 29, 1890. Loading pan was slipped over cartridge before inserting cartridge in breech. Fired into sand butt, section 3. Cartridge bag cut. Chamber sponged out after each round to facilitate loading of projectile. Copper cylinders of 32,000 pounds initial compression and tables of 1890 used in rounds 12, 13, and 14. Oil escaped through rear stuffing box of each cylinder. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
C, 32,000 D, 31,000	4	9	4	9	....	Slight escape of oil at fourth top tap bolt in right cylinder. Copper cylinders of 32,000 pounds initial compression and tables of 1890 used in gauge C. Copper cylinders of 28,000 pounds initial compression used in gauge D, tables of 1890.	
C, 40,970 D, 41,080	5	0	5	0	....	Oil escaped from connecting pipe of cylinders at fifth top tap bolt and at filling hole of right cylinder.	
C, 33,600 D, 33,600	5	0	4	10	....	Bottom rail on left side of top carriage opened 0.09 inch.	
C, 46,880 D, 46,410	5	0	4	8	....	Wires of primer blown out. End of primer burnt off. Breechblock could not be rotated until rear nuts were loosened, due to binding of rear cup of mushroom head.	

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal, at Sandy

[Object of firing, to

Date.	No. of fire.	Powder.			Projectile.			Travel of shot in bore.	Depression.	Instrumental velocity, feet.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
1891.			*Pounds.*			*Lbs.*	*Oz.*	*Inches.*	′	*175 feet from muzzle.*
Apr. 13	15	Du Pont's brown prismatic, N. V., lot 7.	100 100	1,076 1,071+5	Cored shot, band "A," lot 255.	566 5	0 0 sand.	255.15	12	1,796 1,788
			200			571	0			
Apr. 13	16		90 90	968 963+5		570 1	0 0 sand.	255.20	12	1,674 1,671
			180			571	0			
Apr. 13	17		90 95	968 1,016+5		566 5	0 0 sand.	255.15	12	1,698 1,691
			185			571	0			
Apr. 13	18		95 95	1,022 1,017+5		567 3	8 8 sand.	255.25	12	1,736 1,734
			190			571	0			
Apr. 13	19		92 95	990 1,017+5		569 1	8 8 sand.	255.15	12	1,723 1,716
			187			571	0			$100+1\frac{5}{8}^{\circ}$
Apr. 14	20		92 95	990 1,015+5		568 3	0 0 sand.	255.15	12	1,710 Lost.
			187			571	0			
Apr. 14	21		92 95	990 1,015+5		568 3	0 0 sand.	255.15	12	1,703 1,698
			187			571	0			
Apr. 14	22		92 95	990 1,017+5		568 3	0 0 sand.	255.15	12	1,713 1,708
			187			571	0			
Apr. 30	23		150	1,606+5		571	0	255.15	12	1,529 1,528
Apr. 30	24		160	1,718+5		571	0	255.15	12	1,586 1,579

Hook Proving Ground, from September 16, 1890, to April 25, 1892—Continued.

test gun for endurance.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			
C, 39, 220 D, 39, 130	5	0	5	0	....	Breechblock rotated with slight difficulty in closing. Carriage ⅛ inch out of battery when gun was fired. Breechblock opened with difficulty. Rear gas-check cup smoothed down. Spindle of spring lock of tray latch found burred; burrs removed.	Gun mounted on experimental carriage for 8-inch and 10 inch rifles. Cylinder of carriage fitted with steel obturating bars. One-half gallon of oil added to cylinder. Since last firing the spindle of spring lock of tray latch found broken; has been repaired. Obturating electric primers, April 29, 1890. Cartridge bag cut. Fired into sand butt, section 2. Chamber sponged out after each round to facilitate loading of projectile. Connecting pipe of cylinder leaked during the firing. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Tracer attached to upper carriage showed that 9 inches from beginning of recoil upper carriage rose to a height of ⅝ inch. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
C, 34, 240 D, 34, 240	5	0	5	0	....	Carriage ⅛ inch out of battery when gun was fired. Breechblock closed easily. Spring lock of tray latch failed to hold console in forcing block home.	
C, 34, 600 D, 34, 715	5	0	5	0	....	In closing in rotating breechblock last half turn made with slight difficulty.	
C, 37, 950 D, 37, 510	5	0	5	0	....	Carriage ⅛ inch out of battery when gun was fired. Wires of primer blown out.	
C, 36, 875 D, 36, 080	5	0	5	0	....	Carriage ⅛ inch out of battery when gun was fired. Wires of primer blown out. End of primer burnt.	
C, 33, 240 D, 33, 260	5	0	5	0	....	Carriage ⅛ inch out of battery when gun was fired. Large outside gear wheel of elevating apparatus jarred loose, tightened after this round.	Gun mounted on experimental carriage for 8-inch and 10-inch rifles. Cylinders fitted with steel obturating bars. Obturating electric primers, April 29, 1891. Cartridge bag cut. Fired into sand butt, section 4. Chamber sponged out after each round to facilitate loading of projectiles. Loading pan slipped over cartridge before insertion of cartridge in gun. Leakage of oil at rear end of cylinder and in connecting pipe. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Construction of vent shield is such that primer can be inserted and gun fired when crank is one-fourth of a rotation from the firing position. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
C, 34, 330 D, 34, 220	5	0	5	0	....	In closing in rotating breechblock last turn made with slight difficulty. Breechblock opened easily. Shell came out of butt and fell to the right.	
C, 33, 890 D, 34, 000	5	0	5	0	------	In opening in rotating breechblock, first turn made with slight difficulty. All the holding-down bolts in pintle plate and in front transom of top carriage found loosened after this round.	
C, 33, 840 D, 33, 880	4	10	4	10	....	Copper cylinders of 24,000 pounds initial compression and tables of 1887.	
C, 37, 060 D, 36, 260	4	11	4	11	....	In closing in rotating breechblock last turn made with slight difficulty. Copper cylinders of 28,000 pounds initial compression and tables of 1890.	

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal, at Sandy

[Object of firing,

Date.	No. of fire.	Powder.			Projectile.				Travel of shot in bore.	Depression.	Instrumental velocity, feet.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.					
			Pounds.			*Lbs.*	*Oz.*		*Inches.*	′	*175 feet from muzzle.*
1891. May 8	25	Du Pont's brown prismatic, V. D.; density, 1.840.	100 100	1,088 1,081+5	Cored shot, band "A," lot 255.	568 3	0 0	 sand.	255.15	12	1,755 1,757
			200			571	0				
May 8	26		110 110	1,197 1,192+5		567 4	0 0	 sand.	255.15	12	1,857 1,863
			220			571	0				
May 8	27		115 115	1,252 1,247+5		562 6 2	0 8 8	 sand. lead.	255.15	12	1,897 1,897
			230			571	0				
June 10	28	Du Pont's brown prismatic, U. G.; density, 1.820; 55 prisms in cross section.	100 100	1,063 1,056+7	Cored shot, band "A", lot 278.	568 3	0 0	 sand.	255.25	12	1,767 1,757
			200			571	0				
June 10	29		110 115	1,167 1,217+7		570 1	0 0	 sand.	255.15	12	1,877 1,873
			225			571	0				
June 10	30		120 115	1,275 1,213+7		570 1	0 0	 sand.	255.10	12	1,935 1,929
			235			571	0				
June 10	31		120 115	1,273 1,213+7		571	0	natural weight.	255.15	12	1,929 1,930
			235								
June 10	32		100 100	1,068 1,064+7		565 4 2	0 0 0	 lead. sand.	255.15	12	1,747 1,749
			200			571	0				
June 11	33	Du Pont's brown prismatic, U. H.; density, 1.820; 55 prisms in cross section.	110 115	1,172 1,224+7		568 3	0 0	 sand.	255.25	12	1,882 1,880
			225			571	0				
June 11	34		115 120	1,231 1,276+7		568 3	0 0	 sand,	255.25	12	1,907 1,905
			235			571	0				
June 11	35		115 120	1,230 1,272+7		569 1	8 8	 sand.	255.25	12	1,904 1,902 100 + $^{1}_{2}{}^{9}$
			235			571	0				

Hook Proving Ground, from September 16, 1890, to April 25, 1892—Continued.

to prove powder.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			
C, 32,075 D, 32,460	5	0	5	0	....	First velocity frame blown down and broken by blast. In opening breechblock rotated with slight difficulty. Copper cylinders of 32,000 pounds initial compression and tables of 1890.	Gun mounted on experimental carriage for 8 inch and 10-inch rifles, cylinders fitted with steel obturating bars. Depth of oil in cylinders measured 5¾ inches. Cartridge bag cut. Fired into sand butt, section 4. Front cup wiped off and oiled after each round. Chamber sponged out after each round to facilitate loading of projectile. 7½ gallons of oil added to cylinder before firing, June 10, 1891. Loading tray slipped over cartridge bag before insertion of cartridge in breech. Copper cylinders of 28,000 pounds initial compression and tables of 1890 used in rounds 28, 29, and 32. Copper cylinders of 32,000 pounds initial compression and tables of 1890 used in rounds 30 and 31. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
C, 35,150 D, 36,840	5	1	5	1	....	In closing in rotating breechblock last turn made with difficulty. Coppers cylinders of 32,000 pounds initial compression and tables of 1890.	
C, 36,555 D, 37,555	5	1	5	1	....	Copper cylinders of 32,000 pounds initial compression and tables of 1890.	
C, 30,300 D, 29,750	5	0	5	0	....	In closing in rotating breechblock last turn was made with slight difficulty.	
C, 35,560 D, 35,666	5	6	5	6	....	In closing in rotating breechblock last turn was made with slight difficulty.	
F, 37,877 H, 38,600	5	1	5	1	....	....	
F, 37,900 H, 38,700	5	1	4	9	....	In closing in rotating breechblock last turn was made with slight difficulty.	
C, 29,100 D, 29,000	5	0	5	0	....	In closing in rotating breechblock last half turn made with considerable difficulty.	
C, 34,311 D, 35,200	5	1	5	1	....	First primer failed to ignite charge. First velocity frame blown down and broken. Shell came out of butt and fell to the right. Copper cylinder of 28,000 pounds initial compression and tables of 1890 used in gauge C. Copper cylinder of 32,000 pounds initial compression and tables of 1890 used in gauge D.	Gun mounted on experimental carriage for 8-inch and 10-inch rifles. Cylinder fitted with steel obturating bars. Before this firing the rear gas-check cup was filed down. Obturating electric primers, April 11, 1890. Cartridge bag cut. Fired into sand butt, round 33 into section 4; rounds 34 and 35 into section 2. Front cup wiped off and oiled after each round. Chamber sponged out after each round to facilitate loading of projectile. In round 35, when closing breechblock a piece of iron pipe was slipped over crank handle to lengthen it. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
F, 37,440 H, 37,600	....		....		....	In opening in rotating breechblock first turn made with some difficulty. Copper cylinders of 32,000 pounds initial compression and tables of 1890.	
C, 36,861 D, 37,360	....		....		....	Tray latch failed to hold console when the block was being pushed home. In closing in rotating breechblock last turn made with great difficulty. In opening in rotating breechblock first turn made with some difficulty. Copper cylinders of 32,000 pounds initial compression and tables of 1890.	

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal, at Sandy

[Object of firing,

Date.	No. of fire.	Powder.			Projectile.			Travel of shot in bore.	Depression.	Instrumental velocity, feet.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
1891.			*Pounds.*			*Lbs.*	*Oz.*	*Inches.*	'	*175 feet from muzzle.*
July 25	36	Du Pont's brown prismatic, V. O.; density, 1.820; 55 prisms in cross section.	100 100 200	1,083 1,076+7	Cored shot, band "A," lot 278.	571	0	255.10	12	1,671 1,675
July 25	37		115 120 235	1,245 1,283+7		567 4 571	0 0 sand. 0	255.25	12	1,835 1,830
July 25	38		125 125 250	1,354 1,347+7		564 7 571	0 0 sand. 0	255.10	12	1,855 1.859
Sept. 7	39	Du Pont's brown prismatic, V. P.; density, 1.840.	100 100 200	1,105 1,107+8		567 4 571	0 0 sand. 0	255.25	10	Lost. 1,684
Sept. 7	40		110 105 215	1,209 1,149+7	Cored shot, band "A," lot 255.	569 2 571	0 0 sand. 0	255.25	10	1,704 1,713
Sept. 8	41		115 120 235	1,260 1,306+7		570 1 571	0 0 sand. 0	255.25	10	1,787 1,798
Sept. 8	42		125 125 250	1,365 1,358+7		568 3 571	0 0 sand. 0	255.25	10	1,885 1,892
Sept. 8	43	Du Pont's brown prismatic. V. S.; density, 1.840.	110 100 210	1,083 1,076+7	Cored shot, band "A," lot 319.	569 2 571	0 0 sand. 0	255.25	10	1,630 1,637
Sept. 8	44		115 120 235	1,248 1,294+7		566 5 571	0 0 sand. 0	255.25	10	Lost. 1,785
Sept. 8	45		125 125 250	1,357 1,350+7		566 5 571	0 0 sand. 0	255.25	10	1,808 1,818 100+⅛°
										260 feet from muzzle.
Sept. 22	46	Du Pont's brown prismatic; density, 1.840. U. V.	100 100 200	1,098 1,001+7		566 5 571	0 0 sand. 0	255.25	10	1,690 1,696
Sept. 22	47		115 120 235	1,062 1,310+7		562 9 571	0 0 sand. 0	255.25	10	1,813 1,816
Sept. 22	48	Du Pont's brown prismatic; density, 1.840. U. T.	100 100 200	1,086 1,079+7		571	0	255.25	10	1,663 1.672

Hook Proving Ground, from September 16, 1890, to April 25, 1892—Continued.

to prove powder.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			
D, 28, 200 F, 28, 127	4	11	4	11	Wind from right and front, 3 miles an hour.	Copper cylinders of 24,000 pounds initial compression and tables of 1887.	Gun mounted on experimental carriage for 8-inch and 10-inch rifles; cylinders fitted with steel obturating bars. 5½ gallons of oil added to cylinders, depth of oil measuring 5¾ inches. Obturating electric primers, April 11, 1890. Cartridge bag cut. Fired to sea. Chamber sponged out after each round to facilitate loading of projectile. Copper cylinders of 32,000 pounds initial compression and tables of 1890 used in rounds 40 to 42, inclusive. Some of the prisms of this powder found to be without central perforation; rough projection in center of prisms. Tray latch failed to hold console when block was being pushed home. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
D, 33, 450 F, 32, 560	5	0	5	0		Copper cylinders of 32,000 pounds initial compression and tables of 1890 used in gauge D. Copper cylinders of 28,000 pounds initial compression and tables of 1890 used in gauge F.	
D, 35, 823 F, 36, 970	5	0	5	0		First primer failed; wires pulled out. First velocity frame blown down by blast. Copper cylinders of 32,000 pounds initial compression and tables of 1890.	
D, 33, 280 F, 30, 305	4	4	4	4	Wind 20 miles an hour.	Copper cylinders of 24,000 pounds initial compression and tables of 1890.	
D, less than 32, 000 F, less than 32, 000	......		......			In closing in rotating breechblock last quarter revolution of crank made with difficulty.	
D, 32, 000 F, 32, 000	5	1	4	9	Wind 4 miles an hour.	Shot came out of butt; pieces of rotating band came off shot and struck the ground in front of gun.	
D, 32, 850 F, 34, 000	5	0	5	0		Shot came out of butt and fell to the right.	
D, 22. 525 F, 23, 280	5	0	5	0	Wind 7 miles an hour.	Carriage 1¼ inches out of battery when gun was fired. Shot came out of butt and fell to the right. Copper cylinders of 18,000 of 1890.	
D, 29, 400 F, 30, 000	5	0	5	0		Second velocity frame broken. 28,000 coppers of 1890.	
D, 32, 270 F, 32, 480	5	6	5	6		Second velocity frame broken, struck by shot. 32,000 coppers of 1890 in gauge D; 28,000 coppers of 1890 in gauge F.	
D, 23, 000 F, 27, 400	5	1	4	9	Wind 10 miles an hour.	18,000 coppers of 1890	3 gallons of oil added to cylinders. Fired into sand butt. Chamber sponged out and breech mechanism well oiled after each round. Tray latch failed to hold console when breechblock was being pushed home. In rounds 47 and 48 in opening breechblock a piece of iron pipe was slipped over crank handle to lengthen it.
D, 30, 590 F, 31, 435	5	2	4	0		In closing in rotating breechblock last part of revolution made with slight difficulty. 28,000 coppers of 1890.	
D, 25, 380 F, 26, 430	5	0	4	0		18,000 coppers of 1890	

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal, at Sandy

[Object of firing,

Date.	No. of fire.	Powder.			Projectile.		Travel of shot in bore.	Depressions	Instrumental velocity, feet.
		Kind.	Weight.	Number of prisms.	Kind.	Weight			
1891.			*Pounds*			*Lbs. Oz.*	*Inches.*		*260 feet from muzzle.*
Sept. 22	49	Du Pont's brown prismatic; density, 1,840. U. V.	125 125 250	1, 372 1, 365+7	Cored shot, band "A," lot 319.	569 0 2 0 571 0	255 25	10	Lost.
Sept. 23	50	Du Pont's brown prismatic; density, 1,840. U. V.	125 130 255	1, 372 1, 420+7	Cored shot, band "A," lot 319.	568 0 3 0 571 0	255. 25	10	1, 902 1, 916
Sept. 23	51	Du Pont's brown prismatic; density, 1,840. U. T.	125 125 250	1, 356 1, 349+7	Cored shot, band "A," lot 319.	569 0 2 0 571 0	255. 25	10	1, 893 1, 906 $185+1\frac{1}{2}^{\circ}$

[Object of firing, test

1891. Oct. 8	52	German smokeless for 8-inch rifle.	65	....	Cored shot, lot 319.	568 0 3 0 sand. 571 0	255 15	12	1, 732 1, 731 $185+1\frac{1}{2}^{\circ}$

[Object of firing, exhibition before the

1891. Oct. 10	53	German smokeless for 8-inch rifle.	80	....	Cored shot, lot 319.	567 0 4 0 sand 571 0	255. 15	12	1, 960 1, 959 $185+1\frac{1}{2}^{\circ}$

Hook Proving Ground, from September 16, 1890, to April 25, 1892—Continued.

to prove powder.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			
D, 32,000 F, 35,490	5	2	5	0	Wind 10 miles an hour.	In closing in rotating breechblock last part of revolution made with great difficulty, mallet being used. 32,000 coppers of 1890.	Firing conducted by the proof officer.
D, 37,110 F, 38,020	5	3	5	0		A piece of yoke plate 6 inches long broken off left side of top carriage. 32,000 coppers of 1890.	
D, 35,000 F, 37,200	5	3	4	9		32,000 coppers of 1890	

of smokeless powder.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks.	General remarks.
B, 23,360 D, 23,380	4	9	4	9	Wind 14 miles an hour	Slight leakage of oil around filling hole and at obturator bar bolts of cylinders at this round. 18,000 coppers of 1890.	Gun mounted on experimental carriage for 8-inch and 10-inch rifles. Chamber filled with oil before this firing. Before this firing hanger on left yoke plate repaired, clip nearly doubled in thickness. Fired into sand butt, section 2. Obturating electric primers.

Secretary of War and Chief of Ordnance.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks.	General remarks.
C, 34,800 F, 34,960	5	0	5	0	Wind 10 miles an hour.	24,000 coppers of 1890...............	Obturating electric primers. Fired to sea. Pressure taken by Lieutenant Wheeler, Ordnance Department. Velocities taken by Lieutenant Wheeler, Ordnance Department. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal, at Sandy

[Object of firing,

Date.	No. of fire.	Powder.			Projectile.		Travel of shot in bore.	Depression.	Instrumental velocity, feet.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.			
1891.			*Pounds.*			*Lbs. Oz.*	*Inches.*	′	*250 feet from muzzle.*
Oct. 15	54	Du Pont's brown prismatic, V. U., lot 1; density, 1.840.	100 100 200	1,091 1,084+7	Cored shot, band "A," lot 319.	571 0	255.05	12	1,700 1,700
Oct. 15	55		115 120 235	1,253 1,301+7		567 0 4 0 sand. 571 0	255.05	12	1,854 1,855
Oct. 15	56		125 125 250	1,357 1,350+7		566 0 5 0 sand. 571 0	255.05	12	1,921 1,924
Oct. 15	57		125 125 250	1,362 1,351+7		565 0 6 0 sand. 571 0	255.05	12	Lost.
Oct. 17	.....	Brown prismatic, V. T.; density, 1.840.	100	1,080+7		....	....	....	....
Oct. 17	58	Brown prismatic, V.U., lot 1; density, 1.840.	125 130 255	1,360 1,408+7		566 0 5 0 sand. 571 0	255.00	12	Lost. 1,950 175+½°

[Object of firing, test of pneu-

								Elevation. ° ′	
1891. Dec. 4	59	Du Pont's brown prismatic, V. U., lot 1; density, 1.840.	85 85 170	924 918+7	Cored shot, band "A," lot 319.	571 0 4 0 sand. 575 0	255.15	2 5	....

Hook Proving Ground, from September 16, 1890, to April 25, 1892—Continued.

to prove powder.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			
C, 27,360 D, 24,600	5	0	5	0	Wind 5 miles an hour.	Very slight leakage of oil around filling holes of cylinders. Loading tray slipped over cartridge before insertion. 18,000 coppers of 1890.	Gun mounted on experimental carriage for 8-inch and 10-inch rifles. Obturating electric primers. Cartridge bag cut. Chamber sponged out after each round. Rounds 54, 55, 56, and 57 fired into sand butt, section 1; round 58 fired into sand butt, section 2. Copper cylinders of 32,000 of 1890 in rounds 56, 57, and 58. Pressures and velocities taken by Lieut. O. M. Lissak, Ordnance Department. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.
C, 34,500 D, 32,866	5	1	5	1		28,000 coppers of 1890.	
B, 32,100 F, 38,400	5	1	5	1		....	
B, 35,750 D, 34,250	5	1	5	1		Rods of chronograph knocked down by blast. Escape of gas around threads in gauge D noticed.	
....	....		....			Warming charge. No projectile. A number of prisms of unburnt powder found in front of gun.	
D, 37,020 F, 29,220	5	1	5	1		Carriage 3 inches out of battery when gun was fired. New hanger on left yoke plate of top carriage cracked.	

matic disappearing carriage.]

I, less than 18,000 M, 20,680	....		....		Wind from rear, 20 miles an hour.	Spindle of mushroom head tightened before this round. Powder removed from tray to scoop by hand. In closing in rotating breechblock last turn made with slight difficulty. 24½ minutes occupied in lifting gun. First part of motion very slow, last few feet more rapidly. Before firing, gauge on main cylinder replaced by indicator, 1,000 pounds spring in indicator. Gun depressed in recoiling, striking buffers, and rebounding about 6 inches, more or less, and then returning to buffers.	Gun mounted on pneumatic disappearing carriage. Obturating electric primers. Trip valve set at 3 inches from bottom, 6 inches on handle. Scale, ¾ inch on handle to 1 inch in cylinder. Fired to sea. Valve between receiver and main cylinder closed when gun was lifted about half way up. The remainder of

PRESSURE IN CYLINDERS.

	Before lifting gun.	After lifting gun.	Before firing.	After firing.
Receiver......	960	650	300	500
Main cylinder.	650	500	300	300

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal, at Sandy

[Object of firing, test of pneu-

Date.	No. of fire.	Powder.			Projectile.			Travel of shot in bore.	Elevation.		Instrumental velocity, feet.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.					
1891.			*Pounds.*			*Lbs.*	*Oz.*	*Inches.*	°	'	
Dec. 5	60	Du Pont's brown prismatic, V. U., lot 1; density, 1.840.	85 85 170	924 919+7	Cored shot, band "A," lot 819.	571 4 575	0 0 sand. 0	255.05	2	5	....
Dec. 7	61		90 90 180	974 966+7		570 5 575	0 0 sand. 0	255.05	2	5	....

Hook Proving Ground, from September 16, 1890, to April 25, 1892—Continued.

matic disappearing carriage.]

<table>
<tr><th>Pressure per square inch of bore.</th><th>Recoil.</th><th>Counter recoil.</th><th>Wind, strength and direction.</th><th>Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.</th><th>General remarks.</th></tr>
<tr><td><i>Pounds.</i></td><td><i>Ft. In.</i></td><td><i>Ft. In.</i></td><td></td><td></td><td></td></tr>
<tr><td>J, 17,080
M, 19,780</td><td>......</td><td>......</td><td>Wind from right and front, 45°, 21 miles an hour.</td><td>Powder removed from tray to scoop by hand. In closing breechblock last turn made with slight difficulty. Time occupied in lifting gun 10 to 15 seconds from beginning of motion. Gun came into battery with considerable shock. At the discharge the gun moved over about half the arc of recoil and stopped. It then oscillated up and down twice and came down to the buffers, striking them with considerable force and rebounding upward 4 inches.
PRESSURE IN CYLINDERS.<table><tr><th></th><th>Before lifting gun.</th><th>After lifting gun.</th><th>Before firing.</th><th>After firing.</th></tr><tr><td>Receiver......</td><td>910</td><td>675</td><td>360</td><td>580</td></tr><tr><td>Main cylinder.</td><td>650</td><td>450</td><td>360</td><td>875</td></tr></table></td><td>the motion was due to expansion of air in cylinder.
Loading pan 2 inches higher than tray of carriage. A wooden wedge placed on tray to facilitate insertion of cartridge in round 60.
18,000 coppers of 1890 used in round 59.
9,000 coppers of 1890 used in round 60.
Pressures taken and firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.</td></tr>
<tr><td>J, less than 18,000
M, less than 18,000</td><td>......</td><td>......</td><td>Wind from rear and right, 10°, 10 miles an hour.</td><td>Slight difficulty in closing block. Time occupied in lifting gun, 40 seconds. Elevation of piece was changed from + 2° to about 5° and back with ease. Gun moved smoothly back in recoil, stopping at point for which trip valve was set, and then falling to the buffers. There was a slight rebound upward.
PRESSURE IN CYLINDERS.<table><tr><th></th><th>Before lifting gun.</th><th>After lifting gun.</th><th>Before firing.</th><th>After firing.</th></tr><tr><td>Receiver......</td><td>980</td><td><i>a</i>550</td><td>350</td><td>625</td></tr><tr><td>Main cylinder.</td><td>Not taken.</td><td><i>a</i>550</td><td>350</td><td>380</td></tr></table><i>a</i> After equalizing.</td><td>Obturating electric primers.
Trip valve set at 7 inches from bottom in round 61.</td></tr>
<tr><td></td><td></td><td></td><td></td><td>Difficulty in closing breechblock due to unlatching of tray before the block was wholly in. Trip valve set at 6 inches from bottom. Gun had to be lifted about two-thirds of the height into battery by means of jacks. Recoil smooth. Very slight rebound from buffers.</td><td>Valve between receiver and main cylinder closed when gun was lifted about half way up. The remainder of the motion was due to expansion of air in cylinder.</td></tr>
</table>

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal, at Sandy

[Object of firing, test of pneu-

Date.	No. of fire.	Powder.			Projectile.			Travel of shot in bore.	Elevation.		Instrumental velocity, feet.
		Kind.	Weight.	Number of prisms.	Kind.	Weight					
1891.			*Pounds.*			*Lbs.*	*Oz.*	*Inches.*	°	′	
Dec. 8	62	Du Pont's brown prismatic, V. U., lot 1; density, 1.840.	95 95	1,001 993+7	Cored shot, band "A," lot 319.	571 4	0 0 sand.	254.95	2	5	....
			190			575	0				
Dec. 8	63		100 100	1,069 1,082+7		573 2	0 0 sand.	254.95	2	5	....
			200			575	0				
Dec. 9	64		110 115	1,198 1,203+7		570 5	0 0 sand.	254.95	2	5	....
			225			575	0				

Hook Proving Ground, from September 16, 1890, to April 25, 1892—Continued.

matic disappearing carriage.]

<table>
<tr><th>Pressure per square inch of bore.</th><th>Recoil.</th><th>Counter recoil.</th><th>Wind, strength and direction.</th><th>Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.</th><th>General remarks.</th></tr>
<tr><td><i>Pounds.</i></td><td><i>Ft. In.</i></td><td><i>Ft. In.</i></td><td></td><td></td><td></td></tr>
<tr><td>J, 19,970
M, 21,320</td><td>......</td><td>.....</td><td rowspan="2">Wind from rear and right, 10°, 10 miles an hour.</td><td rowspan="2">PRESSURE IN CYLINDERS.
<table>
<tr><th></th><th>Before lifting gun.</th><th>After lifting gun.</th><th>Before firing.</th><th>After firing.</th></tr>
<tr><td>Receiver......</td><td>840</td><td>a500</td><td>365</td><td>625</td></tr>
<tr><td>Main cylinder.</td><td>640</td><td>a500</td><td>365</td><td>365</td></tr>
</table>
a After equalizing.
Gun oscillated up and down twice after passing over about half the arc of recoil. It then settled very slowly until trip valve acted, and then more rapidly to buffers. Slight rebound from buffers.
PRESSURE IN CYLINDERS.
<table>
<tr><th></th><th>Before lifting gun.</th><th>After lifting gun.</th><th>Before firing.</th><th>After firing.</th></tr>
<tr><td>Receiver......</td><td>925</td><td>620</td><td>400</td><td>675</td></tr>
<tr><td>Main cylinder.</td><td>675</td><td>500</td><td>400</td><td>470</td></tr>
</table></td><td rowspan="2">Fired to sea.
Trip valve set at 6 inches from bottom in round 63.
18,000 coppers of 1890.
Pressures taken and firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.</td></tr>
<tr><td>J, less than 18,000
M, less than 18,000</td><td>......</td><td>.....</td></tr>
<tr><td>J, 27,820
M, 28,690</td><td>......</td><td>......</td><td>......</td><td>Time occupied in lifting gun, 40 seconds. Gun came into battery with considerable shock. Circumstances of recoil same as in last round. Screw bolt holding left elevating arm to breech hoop broken during recoil. Gun did not rise when pressure was equalized after firing. Left elevating arm bent by striking carriage.
PRESSURE IN CYLINDERS.
<table>
<tr><th></th><th>Before lifting gun.</th><th>After lifting gun.</th><th>Before firing.</th><th>After firing.</th></tr>
<tr><td>Receiver......</td><td>980</td><td>a580</td><td>413</td><td>b750</td></tr>
<tr><td>Main cylinder.</td><td>675</td><td>a580</td><td>413</td><td>b435</td></tr>
</table>
a After equalizing.
b Equalized to 580 pounds.</td><td>Gun star-gauged February 23, 1892, by Lieut. O. M. Lissak, Ordnance Department, after 64 rounds.</td></tr>
</table>

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal, at Sandy

[Object of firing, test of pneu-

Date.	No. of fire.	Powder.			Projectile.			Travel of shot in bore.	Elevation.		Instrumental velocity, feet.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.					
1892.		Du Pont's brown prismatic, V. U., lot 1; density, 1.840.	*Pounds.*		Cored shot, band "A," lot 319.	*Lbs.*	*Oz.*	*Inches.*	°	'	
Feb. 26	65		85	928		569	0	255.05	1	0	....
			85	918+7		6	0 sand.				
			170			575	0				
Feb. 27	66		90	972		568	0	255.05	1	30	....
			90	970+7		7	0 sand.				
			180			575	0				
Feb. 27	67		100	1,089		570	0	255.05	1	30	....
			100	1,082+7		5	0 sand.				
			200			575	0				
Feb. 27	68		125	1,360		569	0	255.05	1	30	....
			100	1,082+7		6	0 sand.				
			225			575	0				

Hook Proving Ground, from September 16, 1890, to April 25, 1892—Continued.

matic disappearing carriage.]

<table>
<tr><th>Pressure per square inch of bore.</th><th>Recoil.</th><th>Counter recoil.</th><th>Wind, strength and direction.</th><th>Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.</th><th>General remarks.</th></tr>
<tr><td><i>Pounds.</i>
P, 22,870
R, 21,140</td><td><i>Ft. In.</i></td><td><i>Ft. In.</i></td><td></td><td>Spindle of mushroom head tightened before firing. Powder placed on tray and tray raised to gun by hand. Center valve set at 4 inches inside. Return valve wide open. 28 minutes occupied in lifting gun. Gun in recoiling came within about 2 feet of buffers, oscillated up and down twice and then returned to firing position. Check valve between cylinders had not been closed by company's representative before firing.

PRESSURE IN CYLINDERS.
<table>
<tr><th></th><th>Before lifting gun.</th><th>After lifting gun.</th><th>Before firing.</th><th>After firing.</th></tr>
<tr><td>Receiver</td><td>1,000</td><td>a565</td><td>580</td><td>.....</td></tr>
<tr><td>Main cylinder</td><td>.....</td><td>565</td><td>580</td><td>.....</td></tr>
</table>
a After equalizing.</td><td rowspan="2">Since last firing, Dec. 9, the carriage has been modified as follows: A pipe provided with return and check valves connects bottom of main cylinder with top of same. The tubes through head connecting space under piston head with annular space above have been closed.
9,000 coppers of 1890 used in round 65.
18,000 coppers in rounds 66 and 67.
Obturating electric primers.
Trip valve set at 6 inches from bottom.
A wooden wedge placed on tray to facilitate insertion of cartridge.
Fired to sea.
18,000 coppers of 1890.</td></tr>
<tr><td>P, 23,800
R, 22,200</td><td></td><td></td><td></td><td>Gun loaded when at the firing position. Central valve set at 3 inches inside. Gun in recoiling came within 15 inches of buffers; oscillated up and down twice; rose to a height of 4 feet from buffers, and remained there. Escape of gas around threads of gauge R. Gas escaped between copper washer and seat for gauge.

PRESSURE IN CYLINDERS.
<table>
<tr><th></th><th>Before lifting gun.</th><th>After lifting gun.</th><th>Before firing.</th><th>After firing.</th></tr>
<tr><td>Receiver</td><td>.....</td><td>.....</td><td>a 530</td><td>745</td></tr>
<tr><td>Main cylinder</td><td>.....</td><td>.....</td><td>580</td><td>.....</td></tr>
</table>
a After equalizing.</td></tr>
<tr><td>P, 25,415
R, 25,025</td><td></td><td></td><td></td><td>Gun loaded when at a height of 4 feet from buffers. Gun in recoiling came within 15 inches of buffers, oscillated up and down twice, rose to a height of 4 feet from buffers and remained there. Escape of gas around threads of gauge R. Gas escaped between copper washer and seat for gauge.</td><td rowspan="2">A new recoil indicator secured to buffers of carriage so arranged as to indicate jump of gun after striking buffers and also to measure compression of rubber in buffers.</td></tr>
<tr><td>P, 31,240
R, 29,900</td><td></td><td></td><td></td><td>Escape of gas around threads of gauge R. Gas escaped between copper washer and seat for gauge. 24,000 coppers of 1890.</td></tr>
</table>

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal, at Sandy

[Object of firing,

Date.	No. of fire.	Powder.			Projectile.			Travel of shot in bore.	Elevation.	Instrumental velocity, feet.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
1892.			*Pounds.*			*Lbs.*	*Oz.*	*Inches.*	° '	*250 feet from muzzle.*
Mar. 22	69	Brown prismatic, V. U., lot 2; density, 1.840.	90 90 180	985 980+7	Cored shot, band "A," lot 319.	575	0	255.05	....	1,625 1,626
Mar. 24	70		100 100 200	1,094 1,087+7		575	0	255.05	....	1,728 1,726
Mar. 24	71		115 110 225	1,259 1,195+7		575	0	255.05	....	1,867 1,862
Mar. 24	72		125 125 250	1,368 1,361+7		575	0	255.05	....	1,980 1,974

[Object of firing, test of pneu-

1892. Mar. 25	73	Du Pont's brown prismatic, V. U., lot 1.	125 125 250	1,363 1,352+7	Cored shot, lot 319.	575	0	254.85	10 0	....
Mar. 25	74		125 125 250	1,358 1,356+7		575	0	254.95	15 0	....
Mar. 26	75		125 125 250	1,358 1,344+7		575	0	255.05	....	....
Mar. 29	76		120 120 240	1,305 1,299+7		575	0	255.35	2 25	....
Mar. 29	77		115 115 230	1,252 1,246+7		575	0	255.35	2 25	....
Mar. 29	78		110 110 220	1,190 1,187+7		575	0	....	2 25	....

Hook Proving Ground, from September 16, 1890, to April 25, 1892—Continued.

to prove powder.]

Pressure per square inch of bore.	Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.					
Navy, 18,500 I, 21,723			Wind from rear, 5 miles an hour.	18,000 coppers of 1890	Since last firing, Feb. 27, seat for pressure plug has been repaired. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.
Navy, 23,750 J, 22,323				18,000 coppers of 1890	
Navy, 29,055 I, 28,678				18,000 coppers of 1890. Breechblock rotated with difficulty in opening.	
Navy, 35,685 I, 35,882				32,000 coppers of 1890. Breechblock opened and closed with difficulty. Navy gauge broken under head at beginning of three is.	

matic disappearing carriage.]

Pressure per square inch of bore.	Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Navy, 36,828 J, 33,631			Wind from right and rear, 20°, 6 miles an hour.	32,000 coppers of 1890	Obturating electric primers. Fired to sea. Before firing Mar. 29 gas-check cup filed and smoothed. Catch for tray latch smoothed and bruises removed from ears of hinge. Firing conducted in the presence of the Board of Ordnance and Fortification by Lieut. W. W. Gibson, Ordnance Department, assistant proofofficer.
Navy, 36,162 J, 33,648				32,000 coppers of 1890. In closing in rotating breechblock last 3 turns made with some difficulty. Escape of gas around threads of navy gauge. J gauge broken at beginning of threads when being screwed in breechblock.	
J, 33,648			Wind from left and rear, 40°, 5 miles an hour.	Time of flight 33 seconds. Escape of gas into threads of navy gauge. 32,000 coppers of 1890.	
Navy, 31,900 P, 30,873			Wind from rear and right, 15°, 14 miles an hour.		
P, 31,933				Navy pressure gauge broke when being screwed in block.	
P, 28,861 W, 30,000					

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal, at Sandy

[Object of firing,

Date.	No. of fire.	Powder.			Projectile.			Travel of shot in bore.	Elevation.	Instrumental velocity, feet.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
1892.			*Pounds.*			*Lbs.*	*Oz.*	*Inches.*	° '	*250 feet from muzzle.*
Apr. 25	79	Du Pont's brown prismatic, V. U., lot 3; density, 1.830.	100 100	1,085 1,080+7	Cored shot, lot 322.	571 4	0 0 sand.	255.00	....	1,642 1,642
			200			575	0			
Apr. 25	80		110 115	1,194 1,241+7		573 2	0 0 sand.	255.00	....	1,784 1,782
			225			575	0			
Apr. 25	81		125 125	1,350 1,345+7		572 3	0 0 sand.	255.05	....	1,896 1,896
			250			575	0			

[Object of firing, to determine charge

1892. Apr. 25	82	Brown prismatic, V. U., lot 2.	100	1,057+7	Cored shot, lot 322.	569 6	0 0 sand.	255.10	0 10	1,132 1,128
						575	0			

Hook Proving Ground, from September 16, 1890, to April 25, 1892—Continued.

to prove powder.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			
U, 25,800 Z, 25,050	5	6	5	6	Wind from front and right, 15°, 7 miles an hour.	Part of rubber washer in rear cylinder head blown out, allowing cylinder to leak freely. Copper cylinders of 18,000 pounds initial compression and tables of 1890.	Gun mounted on 10-inch proof carriage. 23½ gallons of oil put in cylinders Depth of oil 3/16 inch from top of piston. Obturating friction primers. Fired to sea. Considerable leakage of oil at cylinder head during firing. Reverse fillet made in trunnion ring to fit fillet to trunnion. Pressure gauge screwed into seat by hand, a spanner wrench being used to hold the mushroom head.
U, 31,200 Z, 29,000	5	10	5	10		24,000 coppers of 1890	
U, 36,970 X, 35,835	6	0	6	0		4 gallons of oil added to cylinder before this round. Muzzle of gun in recoiling depressed so much that it struck pile of sand on level with pintle plate. 32,000 coppers of 1890.	

to produce 1,120 feet velocity.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
U, 8,553 X, 7,353	5	0	5	0	....	Fired through screen placed in front of first velocity frame, 129 feet from muzzle.	Velocities and pressures taken by Lieut. C. B. Wheeler, Ordnance Department. Firing conducted by Capt. Frank Heath, Ordnance Department, proof officer.

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet

[Object of firing, to test gun for

Date.	No. of fire.	Powder.				Projectile.		Elevation by Scott sight.	Travel of shot in bore.	Elevation.	Instrumental velocity, feet.	Pressure per square inch of bore.
		Kind.	Weight.		Number of prisms.	Kind.	Weight.					
1892.			*Lbs.*	*Oz.*			*Pounds.*	° ′	*Inches.*	° ′	*250 feet from muzzle.*	*Pounds.*
Apr. 26	83	Du Pont's brown prismatic, V. U.; lot 1.	125	0	1, 361	Cored shot, lot 322.	575	1 28	255. 05	1 30	....	U, 34, 900
			125	0	1, 357+7							
			250	0								
Apr. 26	84		125	0	1, 361		575	1 26	255	1 30	....	U, 36, 060
			125	0	1, 357+7							
			250	0								
Apr. 26	85		125	0	1, 360		575	1 20	255. 05	1 30	....	U, 36, 200
			125	0	1, 354+7							
			250	0								
Apr. 26	86		125	0	1, 361		575	1 24	255. 05	1 30	....	U, 36, 100
			125	0	1, 354+7							
			250	0								
Apr. 26	87		125	0	1, 362		575	1 21	255. 05	1 30	....	U, 35, 766
			125	0	1, 354+7							
			250	0								

Arsenal, at Sandy Hook Proving Ground, from April 26 to July 15, 1892.

accuracy and determine drift.]

Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.								General remarks.
					TARGET.								
					From center of target.				From center of impact.				
					Vertical.		Horizontal.		Vertical.		Horizontal.		
					Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.	
Ft.	*In.*	*Ft.*	*In.*		*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	
6	0	6	0	Wind from front and right, 15°, 6 miles an hour.	2	....	....	2	....	3.9	....	1	Gun mounted on 10-inch proof carriage. Fired at 1-mile target, aimed at upper right corner. Rope attached to right trunnion of elevating band and to iron bar placed in hole for elevating gear to prevent depression of muzzle in recoiling. Bar bent in eighty-fourth round and rope broke in eighty-fifth round. Round 86: New iron bar and rope used as in previous rounds. Round 87: Iron bar and rope used as in previous round. Bar badly bent. Rubber gasket in rear end of cylinder replaced by one of copper before this firing. Cylinder filled with oil, 23½ gallons. Scott's sight used for giving direction and quadrant for elevation. Deflection 12 feet to left corresponds to a horizontal distance at 1-mile target of 19 feet 5 inches. Discrepancy is noticed between elevation as given by quadrant and Scott sight. This was probably caused by motion of seat of sight, which was repaired after this firing. A block of wood 12 by 12 put on floor of top carriage, and well braced, with an iron screw working in it used for giving elevation. There was evidently so much spring to this arrangement that the breech of the gun was thrown violently upward and the muzzle of gun struck soft sand in front and buried itself for about 2 feet as carriage returned to battery in the first round, when no rope was used to keep gun on elevating screw. Muzzle had to be dug out before the gun could be returned to its normal position. Repeated firings on this block must have crushed it somewhat, so that the breech was depressed more and more as the gun was fired, causing the shot to strike higher on the target; the wood, however, was strong enough to hold up gun while elevation was being given. All keys of gears on eccentric wheels of top carriage sheared off during firing. The guides on this carriage do not hold top carriage down on chassis rails, and it consequently raises from 6 to 8 inches above top of chassis rail every time gun is fired. Gun sighted by Lieut. C. B. Wheeler, Ordnance Department. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer. Target observed by Capt. F. Heath, Ordnance Department, and Corporal Burt.
5	11	5	11		4	....	....	1.5	....	1.9	....	0.5	
5	10	5	10		5	....	....	1.5	....	.9	....	0.5	
5	10	5	10		9	....	0	0	3.1	....	1	....	
6	0	6	0		9.5	....	0	0	3.6	....	1	....	
					Center of impact: Feet. Above .... 5.9 Left .... 1. Mean vertical deviation from center of impact..... 2.68 Mean horizontal deviation from center of impact.... .8 Mean deviation from center of impact .... 2.79 Deviation from plane of fire, right........................ 1¼								

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal,

[Object of firing, to test

Date.	No. of fire.	Powder.			Projectile.		Elevation by Scott sight.	Travel of shot in bore.	Depression.	Instrumental velocity, feet.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
1892.			*Lbs.* *Oz.*			*Pounds.*		*Inches.*	° ′	
Apr. 29	88	Du Pont's brown prismatic, V. U., lot 2; density, 1.840.	100 0	1,086+7	Cored shot, lot 322.	567 8 sand. 575	....	255.05	....	....
Apr. 29	89		98 10	1,072+7	Steel shell, lot 305, No. 3, 1891, marked St. Chamond (French).	569 6 sand. 575	....	255.05	1 22	....

at Sandy Hook Proving Ground, from April 26 to July 15, 1892—Continued.

11½-inch armor plate (steel).]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds	*Ft.*	*In.*	*Ft.*	*In.*			
U, 12,600 Z, 12,300	4	0	4	0	Wind from front and right, 6 miles an hour; barometer, 30.09; thermometer, 52°.	Warming charge. Difficulty in hoisting shot due to wet sand clinging to chain of differential pulley. Fired into sand butt. First primer failed, wires of primer pulled out. Slight leakage of oil at rear cylinder head.	Gun mounted on 10-inch proof carriage. Rear cylinder head repacked and cylinder filled with oil. Recoil indicator repaired. Uncompressed copper cylinders and tables of 1890. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
U, 10,854 Z, 9,930	4	0	4	0		Fired at 11½-inch armor plate 129 feet in front of gun. Gun aimed by means of cross wires in the bore at center of circle on plate 30 inches from top and side. Shell struck point aimed at and rebounded; was found in sand with nose pointing toward plate and 8½ feet from it. Shell calipered before firing; length, 35.42 inches; after firing, length, 35.30 inches. Shell apparently uninjured.	

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal,

[Object of firing, to test gun for

Date.	No. of fire.	Powder.			Projectile.		Elevation by Scott sight.	Travel of shot in bore.	Elevation.	Instrumental velocity, feet.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
1892.			*Lbs.* *Oz.*			*Pounds.*	° '	*Inches.*	° '	
May 2	90	Du Pont's brown prismatic, V. U., lot, 3; density, 1.830.	125 0 125 0 250 0	1,358 1,352+7	Cored shot, lot 322.	568 7 sand. 575	....	255	1 0	....
May 2	91		125 0 125 0 250 0	1,358 1,352+7		567 8 sand. 575	1 10	255	1 30	....
May 2	92		125 0 125 0 250 0	1,358 1,352+7		570 5 sand. 575	1 10	255	1 30	....

at Sandy Hook Proving Ground, from April 26 to July 15, 1892—Continued.

accuracy and determine drift.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.								General remarks.
						TARGET.								
						From center of target.				From center of impact.				
						Vertical.		Horizontal.		Vertical.		Horizontal.		
						Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.	
Pounds.	*Ft.*	*In.*	*Ft.*	*In.*		*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	
U, 38,000	5	9	5	9	Wind from right, 90°, 12 miles an hour.	....	....	....	....	....	....	....	....	Gun mounted on 10-inch proof carriage. Round 90: Fired to sea. Wooden step on right side of carriage broken by being struck with hand wheel of elevating gear. Rear cylinder head leaked slightly. Rounds 91 and 92 fired at 1 mile target; aimed at upper right hand corner. Scott sight used. Round 91: Front end of top carriage raised about 5 inches in recoiling. Round 92: Bolts in rear cylinder head tightened. Cylinder leaked considerably. Leakage of oil so great that firing was discontinued. Plane of fire 9¼ inches to the left of the center of impact. Elevating apparatus fitted to gun and carriage before this firing. Before this firing oil removed from cylinder and both cylinder heads taken off. Inspection made of each end of cylinder. It was found that the obturating bar on right side was .04 inch too long, and that of left side .03 inch too long, so that the projecting parts of cylinder head came in contact with ends of obturating bars and left an open space between flange of cylinder and cylinder head. Bolts in rear cylinder head stretched about 1 thread. Right obturating bar bent and buckled ¼ inch to 2 feet 3 inches from front end, and badly scored on under side. Left obturating bar bent and buckled very slightly about same point, and also badly scored. Both slots on large nut on end of piston burred. Scott sight used throughout the firing. Elevation checked each time by quadrant. Target observed by Lieut. O. M. Lissak, Ordnance Department. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
U, 37,877	5	10	5	10		5.5	....	....	2.5	.75	....	....	5	
U, 38,000	5	10	5	10		4	....	....	1.5	....	.75	5	....	
						Center of impact: Feet. Above .... 4.75 Left .... 2 Mean vertical deviation from center of impact... .75 Mean horizontal deviation from center of impact... .05 Mean deviation from center of impact .... .9013 Deviation from plane of fire, right, 9¼ inches.								

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal.

[Object of firing,

Date.	No. of fire.	Powder.			Projectile.		Elevation by Scott sight.	Travel of shot in bore.	Elevation.	Instrumental velocity, feet.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
1892.			*Lbs. Oz.*			*Pounds.*	° '	*Inches.*	° '	*250 feet from muzzle.*
May 7	93	Du Pont's brown prismatic, V. U., lot 4; density, 1.835.	100 0 100 0 200 0	1,086 1,078+7	Cored shot, lot 322.	572 3 sand. 575	....	254.95	....	1,655 1,657
May 7	94		110 0 115 0 225 0	1,209 1,249+7		571 4 sand. 575	....	254.95	....	1,791 1,792
May 7	95		125 0 125 0 250 0	1,365 1,356+7		575	....	255.05	....	1,916 1,915

[Object of firing, to test gun

1892.										
May 9	96	Du Pont's brown prismatic, V. U., lot 1; density, 1.840.	125 0 125 0 250 0	1,363 1,354+7	Cored shot, lot 322.	568 7 sand. 575	1 9	204.95	1 30	....
May 9	97		125 0 125 0 250 0	1,362 1,354+7		567 8 sand. 575	1 2	204.95	1 25	....
May 9	98		125 0 125 0 250 0	1,361 1,354+7		569 6 sand. 575	1 2	255	1 25	....
May 9	99		125 0 125 0 250 0	1,361 1,354+7		568 7 sand. 575	1 2	254.95	1 25	....

at Sandy Hook Proving Ground, from April 26 to July 15, 1892—Continued.

to prove powder.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*F.*	*In.*	*Ft.*	*In.*			
U, 26,000 F, 25,510	4	10	4	10	Wind from right and rear, 10 miles an hour.	18,000 coppers of 1890...........	Gun mounted on 10-inch proof carriage. Obturating friction primers. Fired to sea. Before this firing obturating bars of cylinder removed. It was found that the bars were too long to permit the rear cylinder head to be brought hard up against the packing, a space of about $\frac{1}{16}$ inch being left between the cylinder and head. Both bars were badly bent at their smallest sections and scored their whole length on lower sides by edge of slot in piston head. Bars straightened and smoothed, and shortened at rear ends about $\frac{1}{32}$ inch. Recess about $\frac{1}{16}$ inch deep cut in rear cylinder head opposite ends of bars. 2 bolts added to each obturating bar between bolts near forward end. Velocities and pressures taken by Lieut. O. M. Lissak, Ordnance Department. Firing conducted by Capt. F. Heath, Ordnance Department, proof officer.
U, 32,320 Z, 32,590	5	4	5	4		Leakage of oil at rear head of cylinder. Cylinder tightened. 28,000 coppers of 1890.	
U, 37,920 Z, 38,050	5	8	5	8		Leakage of oil at rear head of cylinder. 32,000 coppers of 1890.	

for accuracy and determine drift.]

						TARGET.								
						From center of target.				From center of impact.				
						Vertical.		Horizontal.		Vertical.		Horizontal.		
						Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.	
						Ft.	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Feet.*	*Feet.*	
U, 39,130	5	11	5	11	Wind from front and right, 20°, 5 miles an hour.	....	....	....	....	....	....	....	....	Gun mounted on 10-inch proof carriage. Fired at 1-mile target; aimed at the upper left-hand corner. Round 96: Sighting shot; miss. Scott sight used throughout the firing, and elevation checked each time by quadrant. Copper cylinders of 32,000 pounds initial compression and tables of 1890.
U, 38,000	......		......			3.5	...	...	1.5	0.25	....	....	0.625	
U, 38,400	......		......			3.5	...	...	2	.25	....	....	1.125	
U, 37,600	......		......			2	...	0.5	....	....	1.25	1.375	....	

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal,

[Object of firing, to test gun

Date.	No. of fire.	Powder.			Projectile.		Elevation by Scott sight.	Travel of shot in bore.	Elevation.	Instrumental velocity, feet.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
1892.			*Lbs.* *Oz.*			*Pounds.*	° '	*Inches.*	° '	
May 9	100	Du Pont's brown prismatic, V. U., lot 1; density, 1.840.	125 0 125 0 250 0	1,361 1,354+7	Cored shot, lot 322.	571 4 sand. 575	1 2	254.95	1 25	....
May 9	101		125 0 125 0 250 0	1,361 1,354+7		563 12 sand. 575	1 2	254.90	1 25	....
May 9	102		125 0 125 0 250 0	1,361 1,354+7		571 4 sand. 575	1 2	254.80	1 25	....
May 9	103		125 0 125 0 250 0	1,361 1,354+7		573 2 sand. 575	1 2	254.80	1 25	....
May 9	104		125 0 125 0 250 0	1,361 1,354+7		566 9 sand. 575	1 2	254.80	1 25	....

[Object of firing, to test pneu-

June 6	105	Du Pont's brown prismatic, V. U., lot 2; density, 1.840.	85 0 85 0 170 0	921 914+7	Cored shot, lot 319.	575	....	254.85	2 0	....
June 6	106		85 0 85 0 170 0	921 914+7		575	....	254.85	2 0	....
June 10	107		85 0 85 0 170 0	921 914+7		575	....	254.85	2 0	....
June 10	108		125 0 125 0 250 0	1,366 1,361+7		570 5 sand. 575	....	254.85	2 0	....

at Sandy Hook Proving Ground, from April 26 to July 15, 1892—Continued.

for accuracy and determine drift.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.								General remarks.
						TARGET.								
						From center of target.				From center of impact.				
						Vertical.		Horizontal.		Vertical.		Horizontal.		
						Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.	
Pounds.	*Ft.*	*In.*	*Ft.*	*In.*		*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Feet.*	*Feet.*	
U, 38,050	5	11	5	11	Wind from front and right, 20°, 5 miles an hour.	5	...		0	1.75	....	.875	.....	Round 101: Deflection 12 minutes to the right. 3¼ gallons oil added to cylinder before round 103. Elevating gear became unclamped after each discharge, allowing breech to strike wooden block placed under it and resting on floor of top carriage. Target observed by Lieut. O. M. Lissak, Ordnance Department. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
U, 37,766	5	11	5	11		4	...	...	.5	.75	....	.375	.....	
U, 36,160	5	11	5	11		2	...		0	....	1.25	.875	.....	
U, 36,140	5	10	5	10		2	...	...	2	....	1.25	.....	1.125	
U, 37,555	5	10	5	10		4	...	...	1.5	.75	....	.....	.625	

Center of impact: Feet.
Above 3.25
Left .... .875
Mean vertical deviation from center of impact... .9375
Mean horizontal deviation from center of impact... .875
Mean deviation from center of impact............ 1.2823
Deviation from plane of fire, right............... 1⅝

matic disappearing carriage.]

....	......		......		Wind from front and left, 6 miles an hour; barometer, 30.05; thermometer, 63°; humidity, 64.	....	Gun mounted on pneumatic disappearing carriage. Obturating electric primers. Fired to sea.
....	......		......			....	
....	0	44¾	0	4		....	
....	0	45	Not taken.			....	

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal,

[Object of firing, to test pneu-

Date.	No. of fire.	Powder.				Projectile.		Elevation by Scott sight.	Travel of shot in bore.	Elevation.		Instrumental velocity, feet.
		Kind.	Weight.		Number of prisms.	Kind.	Weight.					
			Lbs.	Oz.			Pounds.		Inches.	°	'	
1892. June 10	109	Du Pont's brown prismatic, V. U., lot 2; density, 1.840.	85 85 170	0 0 0	921 914+7	Cored shot, lot 319.	572 3 sand. 575	....	254.85	2	0	....
June 10	110		115 110 225	0 0 0	1,092 914+7		569 6 sand. 575	....	254.85	2	0	....
June 11	111		100 100 200	0 0 0	1,092 1,085+7		569 6 sand. 575	....	254.85	2	0	....
June 11	112		85 85 170	0 0 0	921 914+7		570 5 sand. 575	....	254.85	20	0	....
June 11	113		100 100 200	0 0 0	1,092 1,083+7		570 5 sand. 575	....	254.85	20	0	....
June 11	114		115 110 225	0 0 0			575	....	254.85	20	0	....
June 13	115	Brown prismatic, V. U., lot 2.	85 85 170	0 0 0	921 914+7	Shot, lot 332.	575	....	254.85	20	0	....
June 13	116		125 125 250	0 0 0	1,367 1,360+7		569 6 sand. 575	....	....	20	0	....

[Object of firing, to test

June 21	117	French smokeless, B. N.	65	0	....	Cored shot, lot 332.	568 7 sand. 575	....	....	0	0	....
June 22	118		40 40 80	0 0 0	....		570 5 sand. 575	....	....	0	10	1,234 1,235
June 22	119		45 55 100	0 0 0	....		567 8 sand. 575	....	....	0	10	1,452 1,444
June 22	120		60 60 120	0 0 0	....		569 6 sand. 575	....	....	0	10	1,720 1,714

at Sandy Hook Proving Ground, from April 26 to July 15, 1892—Continued.

matic disappearing carriage.]

Pressure per square inch of bore.	Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft. In.*	*Ft. In.*			
....	0 46⅛	0 3⅛	Wind from front and left, 6 miles an hour; barometer, 30.05; thermometer, 63°; humidity, 64.	....	Gun mounted on pneumatic disappearing carriage. Obturating electric primers. Fired to sea.
....	Not taken.	Not taken.		....	
....	0 46⅜	0 3⅛		....	
....	0 45⅛	0 4⅛		....	
....	0 49	0 3⅜		....	
....	0 43⅝	0 2		....	
....	0 45⅛	0 2⅛	....	....	
....	0 42¾	Not taken.	....	....	

French smokeless powder.]

M, less than 24,000 U, less than 24,000	0 15⅛	0 15⅛	....	Volume of black smoke followed the projectile from gun. This was followed after an interval of a few seconds by flame bursting from the muzzle and this in turn by a smaller cloud of yellow smoke. Large quantities of unburnt powder found on ground in front of gun. 24,000 coppers of 1890.	Threads of breechblock smoothed down with file before this firing. 2 ounces of rifle powder in disk in bottom of cartridge bag. Fired to sea. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.
M, less than 24,000 U, less than 18,000	0 22⅛	0 22⅛	....	Quantities of unburnt powder on ground in front of gun. Action of smoke and flame similar to that in previous round. 24,000 coppers of 1890 in gauge M. 18,000 coppers of 1892 in gauge U.	
M, less than 24,000 U, less than 18,000	0 31	0 31	....	Action of smoke and flame similar to that in previous rounds.	
M, less than 24,000 U, 22, 920	0 36⅛	0 6⅜	....	Action of smoke and flame similar to that in previous rounds.	

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal,

[Object of firing.

Date.	No. of fire.	Powder.				Projectile.		Elevation by Scott sight.	Travel of shot in bore.	Elevation.		Instrumental velocity, feet.
		Kind.	Weight.		Number of prisms.	Kind.	Weight.					
1892.			*Lbs.*	*Oz.*			*Pounds.*		*Inches.*	°	'	*288½ feet from muzzle.*
June 24	121	Brown prismatic, V. U., lot 5; density, 1.830.	100 100 200	0 0 0	1,072 1,065+7	Cored shot, lot 322.	572 3 sand. 575	....	254.85	0	10	1,841 1,835
June 24	122		110 105 215	0 0 0	1,179 1,119+7		572 3 sand. 575	....	254.85	0	10	1,921 1,917
June 25	123	Du Pont's brown prismatic, V. U., lot 6; density, 1.830.	100 100 200	0 0 0	1,174 1,067+7		573 2 sand. 575	....	254.85	0	10	1,767 1,754
June 25	124		110 105 215	0 0 0	....		570 5 sand. 575	....	254.85	0	10	1,838 1,826
June 25	125		100 125 225	0 0 0	....		564 11 sand. 575	....	254.85	0	10	1,891 1,884 213½+1½°
July 9	126	Du Pont's brown prismatic, V. U. Lot 7; density, 1.835.	100 100 200	0 0 0	1,071 1,064+7		570 5 sand. 575	....	254.65	0	10	1,658 1,657
July 9	127		110 115 225	0 0 0	1,177 1,225+7		566 9 sand. 575	....	254.65	0	10	1,789 1,781
July 9	128		125 125 250	0 0 0	1,339 1,337+7		569 6 sand. 575	....	254.65	0	10	1,894 1,907
July 15	129	Lot 6.	100 100 200	0 0 0	1,071 1,064+7		569 6 sand. 575	....	254.65	3	0	....
July 15	130	Lot 7.	130 130 260	0 0 0	1,393 1,386+7		570 5 sand. 575	....	254.65	0	15	1,957 1,952

at Sandy Hook Proving Ground, from April 26 to July 15, 1892—Continued.

to prove powder.]

Pressure per square inch of bore.	Recoil.		ou n-ter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			
M, 32,640 U, 34,146	0	46	0	45	Wind from right and rear, 12 miles an hour; barometer, 30.18; thermometer, 74°; humidity, 62.	18,000 coppers of 1890	Gun mounted on pneumatic disappearing carriage. Obturating friction primers. Chamber sponged out after each round. Fired to sea. In rounds 124 and 125 a piece of gaspipe was slipped over crank handle to lengthen it. Velocities and pressures taken by Lieut. C. B. Wheeler, Ordnance Department. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.
M, 41,860 U, 42,100	0	46	0	3½		32,000 coppers of 1892	
M, 27,700 U, 29,700	0	46¼	0	4	Wind from the left, 8 miles an hour; barometer, 30.09; thermometer, 74°; humidity, 78.	18,000 coppers of 1890	
M, 31,965 U, 32,600	0	46½	0	46½		In closing in rotating breechblock last turn made with difficulty. 28,000 coppers of 1890.	
M, 34,800 U, 36,250	0	45	0	3		In closing in rotating breechblock last turn made with great difficulty. 32,000 coppers of 1892.	
M, 25,050 Z, 24,100	0	43¾	0	4½	Wind from front, 8 miles an hour.	24,000 coppers of 1890	Gun mounted on pneumatic disappearing carriage. Obturating friction primers. Fired to sea. Velocities and pressures taken by Lieut. C. B. Wheeler, Ordnance Department. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer. Gun star gauged after round 130, July 21, 1892, by Lieutenant Lissak, Ordnance Department.
M, 29,560 Z, 29,280	0	43½	0	8		28,000 coppers of 1890	
M, 33,800 Z, 33,500	0	43⅞	......			32,000 coppers of 1892. Schooner Henry R. Tilton, situated about 5 miles from gun and about 2 miles from line of fire, hit by projectile on starboard side near stern.	
M, 40,400 Z, 39,660	0	48⅛	0	3¼	Wind from front, 9 miles an hour.	32,000 coppers of 1892	
M, 37,727 Z, 37,764	0	44	......			32,000 coppers of 1892	

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal,

[Object of firing, test of

Date.	No. of fire.	Powder.				Projectile.			Observed time of flight.	Travel of shot in bore.	Elevation.		Instrumental velocity, feet.
		Kind.	Weight.		Number of prisms.	Kind.	Weight.						
1892.			*Lbs.*	*Oz.*			*Lbs.*	*Oz.*	"	*Inches.*	°	'	*288½ feet from muzzle.*
Aug. 12	131	Du Pont's brown prismatic, V. U., lot 7; density, 1.835.	90 90 180	0 0 0	969 962+7	Cored shot, lot 324.	575	0	....	254.85	3	0	....
Aug. 12	132		125 125 250	0 0 0	1,347 1,341+7		575	0	....	254.85	20	0	....
Aug. 12	133		95 95 190	0 0 0	1,027 1,020+7		575	0	....	255.15	3	0	....
Aug. 12	134		105 105 210	0 0 0	1,294 1,283+7		575	0	....	254.85	5	0	....
Aug. 12	135		100 100 200	0 0 0	1,072 1,067+7		575	0	....	254.85	3	0	....
Aug. 12	136		115 115 230	0 0 0	1,234 1,238+7		575	0	29	254.85	15	0	....
Aug. 12	137		105 105 210	0 0 0	1,185 1,175+7		575	0	....	254.85	3	0	....
Aug. 12	138		110 110 220	0 0 0	1,185 1,179+7		575	0	18½	254.85	10	0	....
Aug. 12	139		90 90 180	0 0 0	972 965+7		575	0	32	254.85	20	0	....
Aug. 12	140		100 100 200	0 0 0	1,063 1,060+7		575	0	32½	254.85	20	0	....
Aug. 16	141		120 120 240	0 0 0	1,292 1,285+7	Cored shot, lot 325.	575	0	....	255.05	0	15	1,938 1,927
Aug. 16	142		120 120 240	0 0 0	1,292 1,287+7		575	0	....	254.75	0	15	1,931 1,921
Aug. 16	143		120 123 243	0 0 0	1,292 1,318+7		575	0	....	254.85	10	0	....
Aug. 17	144		120 121 241	0 0 0	1,291 1,296+7		575	0	....	254.80	0	15	1,933 1,932
Aug. 17	145		120 121 241	0 0 0	1,292 1,298+7		575	0	....	254.70	10	0	....
Aug. 17	146		120 121 241	0 0 0	1,295 1,298+7		575	0	....	254.70	10	0	....

at Sandy Hook Proving Ground, from August 12 to November 30, 1892.

pneumatic disappearing carriage.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			
P, 25,400 U, 24,866	0	46⅛	0	4	Wind from front and right, 10 miles an hour; barometer, 29.95; thermometer, 85°; humidity, 53.	18,000 coppers of 1890	Gun mounted on pneumatic disappearing carriage. Obturating friction primers. Fired to sea. Variation in charge was to determine maximum charge to use for test, the powder being irregular.
P, 42,000 U, 41,431	0	47	....			28,000 coppers of 1890	
A, 28,400 M, 25,683	Lost.		Lost.			18,000 coppers of 1890	
A, 37,240 M, 35,075	Lost.		Lost.			28,000 coppers of 1890	
B, 27,568 Z, 29,527	0	47½	0	2¼		18,000 coppers of 1890	
A, 35,338 M, 34,311	0	45¾	0	8		24,000 coppers of 1890	
A, 26,600 M, 28,186	Lost.		Lost.			24,000 coppers of 1890	
A, 30,527 M, 32,480	0	47⅛	....			24,000 coppers of 1890	
B, 22,166 Z, 24,440	0	46	0	2¼		18,000 coppers of 1890	
A, 23,909 M, 22,984	0	47	....			18,000 coppers of 1890	
A, 36,933 M, 37,309	Lost.		Lost.		Wind from right and rear, 11 miles an hour; barometer, 30.28; thermometer, 81°; humidity, 54.	32,000 coppers of 1892	Gun mounted on pneumatic disappearing carriage. Chamber sponged out after each round. Ramming apparatus lowered to permit use of hand rammer.
B, 36,457 M, 36,033	Lost.		Lost.			32,000 coppers of 1892	
A, 39,220 M, 40,311	0	47	0	1½		32,000 coppers of 1892	
A, 36,954 M, 38,127	0	46	0	2		32,000 coppers of 1892. Breech-block opened very hard in rotating.	
B, 38,300 M, 39,814	0	46⅞	0	1⅛		32,000 coppers of 1892	
A, 40,127 M, 39,900	0	46⅝		1¾		32,000 coppers of 1892	

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal, at Sandy

[Object of firing, to test

Date.	No of fire.	Powder.			Projectile.		Observed time of flight.	Travel of shot in bore.	Elevation.	Instrumental velocity, feet.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
			Lbs. *Oz.*			*Lbs.* *Oz.*		*Inches.*	° '	
1892. Aug. 18	147	Du Pont's brown prismatic, V. U., lot 7; density, 1.835.	120 0 120 0 240 0	1,293 1,289+7	Cored shot, lot 325.	575 0	....	254.85	10 0	....
Aug. 18	148		120 0 120 0 240 0	1,293 1,289+7		575 0	....	254.80	10 0	....
Aug. 18	149		120 0 120 0 240 0	1,293 1,289+7		575 0	....	....	....	....
Aug. 18	150		120 0 120 0 240 0	1,294 1,285+7		575 0	....	....	10 0	....
Aug. 18	151		120 0 120 0 240 0	1,294 1,285+7	Cored shot, lot 324.	575 0	....	....	10 0	....
Aug. 18	152		120 0 120 0 240 0	1,294 1,285+7		575 0	....	....	10 0	....
Aug. 18	153		120 0 120 0 240 0	1,294 1,285+7		575 0	....	....	10 0	....
Aug. 18	154		120 0 120 0 240 0	1,294 1,285+7		575 0	....	....	10 0	....
Aug. 18	155		120 0 120 0 240 0	1,294 1,285+7		575 0	....	....	10 0	....
Aug. 18	156		120 0 120 0 240 0	1,294 1,285+7		575 0	....	....	10 0	....

Hook Proving Ground, from August 12 to November 30, 1892—Continued.

carriage for rapidity.]

Pressure per square inch of bore.	Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
....	....	....	Wind from front, 10 miles an hour.	....	Obturating friction primers. Fired to sea. Velocities and pressures taken by Lieut. F. P. Peck, Ordnance Department. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, in the presence of the Board of Ordnance and Fortification.
....	....	....		....	
....	....	....		....	
....	....	....		....	
....	....	....		....	
....	....	....		....	
....	....	....		....	
....	....	....		....	
....	....	....		....	
....	....	....		....	

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal, at Sandy

[Object of firing.

Date.	No. of fire.	Powder.				Projectile.			Observed time of flight.	Travel of shot in bore.	Elevation.		Instrumental velocity, feet.
		Kind.	Weight.		Number of prisms.	Kind.	Weight.						
1892.			*Lbs.*	*Oz.*			*Lbs.*	*Oz.*	"	*Inches.*	°	'	*288⅛ feet from muzzle.*
Aug. 19	157	Du Pont's brown prismatic, V. U., lot 8; density, 1.840.	100 100 200	0 0 0	1,075 1,068+7	Cored shot, lot 324.	575	0	....	254.85	0	20	1,806 1,801
Aug. 19	158		100 100 200	0 0 0	1,075 1,069+7		575	0	....	254.85	0	20	1,839 1,828 $213\frac{1}{8}+\frac{15}{2}$°

[Object of firing, test of pneu-

1892.													
Aug. 31	159	Du Pont's brown prismatic, V. U., lot 7; density, 1.835.	120 120 240	0 0 0	1,292 1,286+7	Cored shot, lot 324.	568 7 575	0 0 sand. 0	....	254.55	15	0	....
Aug. 31	160		120 120 240	0 0 0	1,292 1,286+5		570 5 575	0 0 sand. 0	....	254.55	15	0	....
Aug. 31	161		120 120 240	0 0 0	1,292 1,286+5		566 9 575	0 0 sand. 0	....	254.55	15	0	....
Aug. 31	162		120 120 240	0 0 0	1,292 1,286+7		567 8 575	0 0 sand. 0	....	254.55	20	0	....

Hook Proving Ground, from August 12 to November 30, 1892—**Continued.**

to prove powder.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			
A, 37,600 M, 37,633	0	46	0	2½	Wind from right and front, 6 miles an hour; barometer, 30.22; thermometer 79°; humidity, 68.	32,000 coppers of 1892........	Gun mounted on pneumatic disappearing carriage. Obturating friction primers. Fired to sea. Rear cup removed and placed in lathe and bearing surface smoothed down by a float file. Velocities and pressures taken by Lieut. F. P. Peck, Ordnance Department. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
B, 50,960 M, 61,472	0	46¾	0	3¼		32,000 coppers of 1892. Breechblock stuck very badly in rotating in opening. On opening breechblock it was found that first and last 3 threads on upper side show marks of bearing, and the last 3 slight marks of scoring. The lip of front cup was turned in all the way around about .05 of an inch. The rear cup was expanded to a tight bearing, and seems to have been made of very soft steel. Breechblock taken out and all the threads of block smoothed down with fine emery cloth. Front cup of gas check taken out and put in lathe and the lip sprung out so it would fill seat in gun.	

matic disappearing carriage.]

A, 38,473 M, 38,000	0	47	....	Wind from rear and right, 8 miles an hour; barometer, 30.01; thermometer, 78°; humidity, 79.	32,000 coppers of 1892..........	Gun mounted on pneumatic disappearing carriage. Obturating friction primers. Fired to sea. In rounds 160 to 162 inclusive, in closing and opening breechblock rotated with difficulty. After round 161 rear gas-check cup smoothed off, which did not relieve sticking. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, in the presence of the Board of Ordnance and Fortification.
B, 36,954 M, 38,077	0	46¼	....		32,000 coppers of 1892..........	
A, 39,178 Z, 38,969	0	46⅝	....		32,000 coppers of 1892..........	
B, 41,680 M, 41,523	0	46½	....		32,000 coppers of 1892..........	

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal, at Sandy

[Object of firing, to prove

Date.	No. of fire.	Powder.			Projectile.		Ob-served time of flight.	Travel of shot in bore.	De-pres-sion.	Instru-mental velocity, feet.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
1892. Oct. 19	163	Du Pont's brown prismatic, V. P., lot 14; density, 1.835.	*Lbs.* *Oz.* 100 0 100 0 200 0	1,056 1,049+7	Cored shot, lot 324.	*Lbs.* *Oz.* 570 0 5 0 sand. 575 0	....	*Inches.* 254.60	′ 22½	*250 feet from muzzle.* 1,670 1,678

[Object of firing, to obtain veloci-

Date.	No. of fire.	Powder Kind.	Powder Weight.	Number of prisms.	Projectile Kind.	Projectile Weight.	Observed time of flight.	Travel of shot in bore.	Depression.	Instrumental velocity, feet.
1892. Oct. 19	164	Brown prismatic, V. U., lot 7; density, 1.835.	100 9	1,076+7	Cored shot, lot 324.	575 0 including sand.	....	254.65	20	1,159 1,163

[Object of firing, to prove

Date.	No. of fire.	Powder Kind.	Powder Weight.	Number of prisms.	Projectile Kind.	Projectile Weight.	Observed time of flight.	Travel of shot in bore.	Depression.	Instrumental velocity, feet.
1892. Oct. 19	165	Brown prismatic, V. P., lot 14; density, 1.835.	110 0 115 0 225 0	1,161 1,207+7	Cored shot, lot 324.	568 0 7 0 sand. 575 0	....	254.65	27½	1,796 1,781

Hook Proving Ground, from August 12 to November 30, 1892—Continued.

powder made for 12-inch rifle.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			
A, 24,850 M, 24,680	5	10	5	10	Wind from right, 15 miles an hour; barometer, 29.93; thermometer, 64°; humidity, 79.	No. 1 stamped on base of shot. With the sights as they are now aim for the under side of the beam of the butt over opening. 18,000 coppers of 1890.	Gun mounted on 10-inch proof carriage. Fired into new sand butt. 22 gallons 1 pint of oil in cylinders.

ties in connection with deck plate.]

A, 10,660 M, 10,460	4	6	4	6	Wind from right, 15 miles an hour; barometer, 29.93; thermometer, 64°; humidity, 79.	Uncompressed copper cylinders, gauge A. 9,000 coppers, gauge M. No. 3 stamped on base of shot. All nuts on bolts tightened. Nuts on spindle of mushroom head tightened.	

powder for 12-inch rifle.]

A, 28,862 M, 29,291	5	11½	5	11¼	Wind from right, 15 miles an hour; barometer, 29.93; thermometer, 64°; humidity, 79.	No. 4 stamped on base of shot. 24,000 coppers of 1890.	Since last firing, May 9, cylinders provided with a new steel piston rod and new clip guide fitted to top carriage. 1¾ inches cut off piston rod before being put in cylinder, to give clearance for nut at front rod.

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal, at Sandy

[Object of firing, to obtain velocities

Date.	No. of fire.	Powder.			Projectile.		Observed time of flight.	Travel of shot in bore.	Elevation.	Instrumental velocity, feet.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
1892.			*Lbs. Oz.*			*Lbs. Oz.*		*Inches.*		*250 feet from muzzle.*
Oct. 19	166	Du Pont's brown prismatic, V. U., lot 7.	95 0	1,015+7	Shot, lot 324.	575 0	....	254.65	....	1,098 1,088 $175+1\frac{3}{8}$°

[Object of firing, test

1892. Oct. 19	167	Du Pont's brown prismatic, V. U., lot 7.	98 8	1,058+7	Shell marked St. Chaumond, France, No. 4, 1891, lot 305.	572 0 3 0 sand. 575 0	....	254.75	....	....

Hook Proving Ground, from August 12 to November 30, 1892—Continued.

in connection with deck plate.]

Pressure per square inch of bore.	Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds. A, 8,250 M, 10,540	*Ft. In.* 4 6	*Ft. In.* 4 6	Wind from right, 15 miles an hour.	½ gallon of oil added to cylinder. No. 5 stamped on base of shot. Uncompressed copper cylinders.	Gun mounted on 10 inch proof carriage. Fired to sea.

of 11½ inch armor plate.]

A, 10,645 M, 10,540	....	....	Wind from right, 15 miles an hour.	Fired at 11½-inch armor plate 129 feet in front of gun. The gun was aimed at a circle 10 inches in diameter, laid off on the plate so that its center was 30 inches from the top and right edge. The gun was sighted by means of sights placed in the muzzle and breech of the gun. The shell struck the point aimed at, penetrated plate, entering the backing about 8 inches and then rebounded, and was found in the sand 9 feet from the plate, with point turned toward it. The shell calipered before firing 35.43 inches. The shell calipered after firing 35.37 inches. Diameter of shell 10 inches from base before firing, 9.943 inches. Diameter of shell 10 inches from base after firing, 9.943 inches. The shell was apparently uninjured.	Leakage of oil at rear end of cylinder at each discharge. Obturating friction primers. Velocities and pressures taken by Lieut. F. P. Peck, Ordnance Department. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal, at Sandy

[Object of firing,

Date.	No. of fire.	Powder.				Projectile.			Observed time of flight.	Travel of shot in bore.	Depression.	Instrumental velocity, feet.
		Kind.	Weight.		Number of prisms.	Kind.	Weight.					
1892.			*Lbs.*	*Oz.*			*Lbs.*	*Oz.*		*Inches.*	′	*250 feet from muzzle.*
Nov. 2	168	Du Pont's brown prismatic, V. U., lot 0; density, 1.850.	100 100 200	0 0 0	1, 065 1, 058+7	....	565 10 575	0 0 sand. 0	....	254. 65	40	1, 730 1, 704
Nov. 2	169		110 115 225	0 0 0	1, 174 1, 220+7	....	570 5 575	0 0 sand. 0	....	254. 65	40	1, 808 1, 772
Nov. 2	170		125 125 250	0 0 0	1, 333 1, 326+7	....	568 7 575	0 0 sand. 0	....	254. 65	40	1, 909 1, 817
Nov. 7	171	Brown prismatic, V. U., lot 7.	100 100 200	0 0 0	1, 077 1, 070+7	Cored shot, lot 324.	570 5 575	0 0 sand. 0	....	253. 65	40	1, 727 1, 721

[Object of firing, to prove

1892. Nov. 7	172	Brown prismatic, V. P., lot 14.	125 125 250	0 0 0	1, 319 1, 312+7	Cored shot, lot 324.	569 6 575	0 0 sand. 0	....	253. 65	40	1, 924 1, 915

[Object of firing,

1892. Nov. 7	173	Brown prismatic, V. U., lot 9.	125 125 250	0 0 0	1, 333 1, 326+7	Cored shot, lot 324.	570 5 575	0 0 sand. 0	....	253. 75	40	1, 945 1, 935

Hook Proving Ground, from August 12 to November 30, 1892—Continued.

to prove powder.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			
M, 25,240 Z, 25,600	5	11½	5	11½	Wind from left and front, 30°, 8 miles an hour; barometer, 30.18; thermometer, 36°; humidity, 88.	No. 6 stamped on base of shot. Bad leakage, rear cylinder head. After this round bolts in rear cylinder head were set up very tightly with hammer and set. Locking nut on left-hand wheel of elevating gear set by depression of breech in discharge. 18,000 coppers of 1890 used in gauge M. 24,000 coppers of 1890 used in gauge Z.	Gun mounted on 10-inch proof carriage. 22½ gallons of glycerin and water 1 to 1 in cylinder. Since last firing both cylinder heads repacked, copper packing being used. Bolts in head increased in diameter from 1⅛ to 1¾ inches, and a groove has been made in rear end of cylinder and a wire inserted in this groove to stop leakage of oil when wire is squeezed by bolts in head. Shot gauged before firing. Obturating friction primers. Fired into sand butt. Velocities and pressures taken by Lieut. E. St. J. Greble, Second Artillery. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
M, 31,850 Z, 31,564	5	3½	5	3½		No. 7 stamped on base of shot. 28,000 coppers of 1890.	
M, 38,000 Z, 37,400	5	10	5	10		No. 8 stamped on base of shot. Pintle pin raised 6¾ inches and did not return; old crack in pintle increased in length about 1 inch. Pintle tongue bent near pin. Leakage of oil at rear cylinder head very bad, and as it could not be stopped firing was discontinued. 32,000 coppers of 1890.	
M, 29,200 Z, 29,070	5	4½	5	4½	....	No. 9 stamped on base of shot. Warming charge. Slight leak at rear stuffing box of cylinder. Cylinder head tightened. Bolts in obturating bar, right side, leaking slightly. Bolts tightened.	Gun mounted on 10-inch proof carriage. Obturating friction primers. Shot gauged before firing. Fired into sand butt.

powder made for 12-inch rifle.]

M, 35,050 Z, 34,870	5	6½	5	6½	....	No. 3 stamped on base of shot. Slight leakage at rear stuffing box and obturating bar bolts in both sides of cylinder. Stuffing box and bolts tightened. It is calculated from these results that in 12-inch B. L. rifle 390 pounds would give about the maximum pressure with about 1,900 feet velocity.	Since last firing a ring, 1¼ by 1¼ inches, shrunk on collar of pintle plate. Pintle tongue straightened. A new set screw through pintle plate to hold pintle pin.

to prove powder.]

M, 36,080 Z, 36,500	5	6½	5	6½	....	No. 12 stamped on base of shot. Front part of pintle plate bent ¾ inch from top of pintle plate; back part of the tongue is bearing on the top of plate. Elevating gear allowed breech of gun to depress, breech hoop striking top carriage.	Rear cylinder head repacked and cylinder filled with glycerin and water 1 to 1—22½ gallons.

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal, at Sandy

[Object of firing, to prove

Date.	No. of fire.	Powder.			Projectile.		Observed time of flight.	Travel of shot in bore.	Depression.	Instrumental velocity, feet.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
1892. Nov. 7	174	Brown prismatic, V. P., lot 14.	*Lbs.* *Oz.* 125 0 125 0 250 0	1,319 1,312+7	Cored shot, lot 324.	*Lbs.* *Oz.* 569 0 6 0 sand. 575 0	....	*Inches.* 258.65	....	*250 feet from muzzle.* 1,927 1,922

[Object of firing,

1892. Nov. 30	175	Du Pont's brown prismatic, V. U., lot 10; density, 1.835.	100 0 100 0 200 0	1,064 1,057+7	Cored shot, lot 324.	575 0	....	$254\frac{7}{16}$	′ 40	1,697 1,700 $400+\frac{192}{2}$
Nov. 30	176		110 0 115 0 225 0	1,168 1,213+7		575 0	....	$254\frac{9}{16}$	40	1,850 1,835 $400+\frac{192}{2}$
Nov. 30	177		115 0 125 0 240 0	1,222 1,321+7		575 0	....	254.50	40	1,905 1,901 $350+\frac{249}{2}$

NOTE.—Rounds 178 to 210 published in Report of

Hook Proving Ground, from August 12 to November 30, 1892—Continued.

powder made for 12-inch rifle.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks
Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			
M, 35,960 Z, 35,360	5	7	5	7	....	No. 11 stamped on base of shot. Holding-down bolts on pintle plate tightened. Front wheels of carriage lifted about 4 inches from traverse circle. Front part of pintle tongue bent ⅜ inch.	Forks of carriage connecting with tongue bent down ⅜ inch in round 174. Since last firing a lead wire has been substituted for the copper wire used in previous firing, to prevent escape of fluid through rear cylinder head, and the teat projecting into cylinder about ¼ inch has had a groove cut in it about ⅛ inch deep, ⅛ inch wide, close to edge, to enable it to act as the ordinary gas checks; that is, by expanding outward to prevent leakage of fluid. This arrangement was very successful. The top of the pintle plate is about 2 inches higher than the fork on carriage connecting with tongue. This, with clips on top carriage, causes bottom carriage to jump up at front end about 3 inches. When there are clips on the top carriage I think the front traverse circle should be made so as to permit of clips on bottom carriage engaging under them. This would prevent tendency of whole system to rise, especially at the time when rear wheels of top carriage just begin to move up inclined plane. Velocities and pressures taken by Lieut. E. St. J. Greble, Second Artillery. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.

to prove powder.]

P, 25,450 X, 25,939	5	10½	5	10½	Wind from right and rear, 25 miles an hour; barometer, 30.05; thermometer, 32°; humidity, 80.	No. 10 stamped on base of shot. Shot came out of butt and fell to the right near field butt No. 2. 18,000 coppers of 1890.	Gun mounted on 10-inch proof carriage. Obturating friction primers. Fired into sand butt. Since last firing rear buffer frames moved back 7 inches and another ring shrunk on collar of pintle plate. Cylinder filled with oil. Shot gauged before firing. Velocities and pressures taken by Lieut. F. P. Peck, Ordnance Department. Firing conducted by Lieut. E. St. J. Greble, Second Artillery.
P, 32,036 X, 32,540	5	11¾	5	11¾		No. 15 stamped on base of shot. 18,000 coppers of 1890.	
P, 36,556 X, 36,939	6	0	6	0		No. 16 stamped on base of shot. Shot came out of butt and fell to the right near field butt No. 2. 32,000 coppers of 1890.	

the Chief of Ordnance for 1894, pages 270 to 287.

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal,

[Object of firing, to determine velocity for use in firing

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Powder. Number of prisms.	Projectile. Kind.	Projectile. Weight.	Observed time of flight.	Travel of shot in bore.	Depression.	Instrumental velocity, feet.
1894. Jan. 17	211	Du Pont's brown prismatic, W. H., lot 4; density, 1.850.	*Lbs.* *Oz.* 90 0 87 4 177 4	954 919+7	Cored shot, lot 320.	*Lbs.* *Oz.* 575 0	....	*Inches.* 254.25	' 12	*263 feet from muzzle.* {1,598 {1,602 $188+\frac{150}{2}$ and $188+\frac{151\frac{1}{2}}{2}$

[Object of firing, to test Midvale Holtzer

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Powder. Number of prisms.	Projectile. Kind.	Projectile. Weight.	Observed time of flight.	Travel of shot in bore.	Depression.	Instrumental velocity, feet.
1894. Jan. 18	212	Du Pont's brown prismatic, W. H., lot 4; density, 1.850.	90 0 93 3 183 3	954 981+7	Midvale Holtzer A. P. shot, lot 559. No. 156.	576 0	....	254.25	4	....
Jan. 18	213		90 0 93 3 183 3	954 981+7	No. 95.	577 8	....	254.35	° ' 2 20	....

at Sandy Hook Proving Ground, from January 17 to September 27, 1894.

at 11½-inch armor plate to test Midvale A. P. shot.]

Pressure per square inch of bore.	Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft. In.*	*Ft. In.*			
D, 22,700 H, 22,117	5 11	3 5	Wind from right and rear, 10 miles an hour; barometer, 30.73; thermometer, 29°; humidity, 52.	Fired to sea. Projectile struck the water and ricochetted once. 18,000 coppers of 1892.	Gun mounted on 10-inch proof carriage. Obturating friction primers. Before firing Jan. 17, 1894, the following repairs had been made to the carriage: A new piston rod increased in diameter from 3 to 3.125 inches outside diameter. A new rear transom put in chassis, glands and cylinder head bored out to 3.135 inches diameter. Ends of cylinder champered out for copper gaskets, which were placed in front and rear ends of cylinder. New front and rear clips; new pin and nuts to connect braces with piston hangers. The elevating hand wheels were straightened, also recoil marker. New bolts in clips and angle irons which hold top carriage. Firing conducted by Lieut. M. F. Harmon, First Artillery.

projectile against 11½-inch armor plate.]

Pressure per square inch of bore.	Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
F, 22,408 J, 21,554	5 11	4 10	Calm; barometer, 30.86; thermometer, 36°; humidity, 91.	Fired at 11½-inch armor plate 129 feet from muzzle. Aimed 2 feet from top and 4 feet 8 inches from right edge. Struck the point aimed at and penetrated plate and backing. The plate was cracked horizontally from center of hole to the right, taking a slightly upward course to the end of plate. Another crack started from the lower left side of hole and ran diagonally to old crack.	From round 211 the charge was calculated to produce 1,625 feet velocity. Owing to the wire screens in the 2 velocity frames being at different distances apart, and this fact not being recorded at the time, the velocity of round 211 was at first recorded too low by 10 feet, and the error was not detected until after firing the 2 following rounds. Assuming the corrected velocity for round 211 for 183 pounds 3 ounces was 1,635 feet. Firing conducted by Lieut. M. F. Harmon, First Artillery.
F, 23,587 Z, 23,231	5 10	5 10		Aimed 2 feet 6 inches from bottom and 2 feet 6 inches from right edge. Shot struck the point aimed at, penetrated plate, backing, and sand, came out and fell in water 500 yards beyond; recovered apparently uninjured.	

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal, at

[Object of firing, test of Midvale Holtzer

Date.	No. of fire.	Powder.			Projectile.		Ob-served time of flight.	Travel of shot in bore.	Eleva-tion.	Instru-mental velocity, feet.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
			Lbs. *Oz.*			*Lbs.* *Oz.*		*Inches.*	° ′	
1894. Mar. 23	214	Du Pont's brown prismatic, W. H., lot 4; density, 1.850.	90 0 91 0 181 0	953 957+7	Midvale Holtzer A. P. shot, lot 578.	No. 171. {574 8	....	254.25	0 56½	....
									De-pression. ° ′	
Mar. 23	215		90 0 91 0 181 0	953 957+7		No. 272. {575 0	....	254.40	2 55	....

Sandy Hook Proving Ground, from January 17 to September 27, 1894—Continued.

A. P. projectiles against 11¼-inch armor plate.]

Pressure per square inch of bore.	Recoil.	Counter recoil.	Wind, strength and direction.	General remarks.
Pounds.	*Ft. In.*	*Ft. In.*		
D, 23,683 H, 23,354	....	....	Wind right and rear, 21 miles an hour; barometer, 29.81; thermometer, 50°; humidity, 87.	Gun mounted on 10-inch proof carriage. Fired at 11¼-inch armor plate, 129 feet from muzzle. Plate marked 4,704 B 1. Velocity at impact, 1,625 feet per second, Aimed at the circle marked 6 on picture No. 1. This shot (No. 171) passed through the armor plate, the backing, and about 26 feet of sand; then came out from the top of the sand and fell on the beach 120 yards to the left and beyond the butt, where it was recovered apparently uninjured. About 2½ hours after firing, and while standing as shown in the platinotype herewith, two patches of metal snapped off from the surface of this projectile with considerable violence. The picture shows one continuous patch; its extremities constitute the 2 meant. The portion between them was still intact when the projectile was inspected, about 10 o'clock p. m., 23d instant. The next morning it was found scaled off also, and the projectile presented the appearance indicated by the picture. This was its appearance at noon the 25th instant. This morning (the 26th) another patch, about the size of the one on the left in the photograph, was found scaled off to the right and in continuation of that shown in the picture. The scaling extends 18 inches around the projectile, and is 5 inches wide at the widest part (the left end in the picture). The extreme thickness of metal which scaled off is about ⅜ of an inch. No crack has been found on the projectile except in continuation of the scaling from the surface. Present weight, Mar. 26, 571 pounds.
D, 23,427 H, 23,573	....	....		No. 272 aimed at circle marked 7 on picture No. 2. Passed through the plate and backing and penetrated about 24 feet into the sand, remaining in the butt. It was not removed until about 10 o'clock the 24th instant. The scaling is of less depth than in case of No. 171; it extends 21 inches around the projectile, and is 3 inches wide at the widest part; is nearly all shown in the picture. When found little or no metal had become detached. The chips were so loose, however, that they were detached by bringing the projectile in from the butt. It remains at present as it was when recovered. Present weight, Mar. 26, 572 pounds. Firing conducted by Lieut. M. F. Harmon, First Artillery.

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal, at

[Object of firing,

Date.	No. of fire.	Powder.			Projectile.		Observed time of flight.	Travel of shot in bore.	Depression.	Instrumental velocity, feet.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
1894.			*Lbs. Oz.*			*Lbs. Oz.*		*Inches.*		*250 feet from muzzle.*
April 6	216	Du Pont's brown prismatic, V. U., lot 14; density, 1.830.	100 0 100 0 200 0	1,075 1,067+7	Solid shot, lot 502.	575 0	....	254.05	....	1,783 1,794
April 6	217		86 9 115 0 201 9	952 1,230+7		575 8	....	254.25	....	1,820 1,830

[Object of firing, to test the special

1894. Sept. 26	218	Du Pont's brown prismatic, V. U., lot 17; density, 1.850.	119 13½ 119 13½ 5 240 0	1,247 1,249 Igniter.	Solid shot, lot 623.	579 0	....	255.15	55	....
Sept. 27	219		119 13½ 119 13½ 5 240 0	1,246 1,247 Igniter.	Solid shot, lot 537.	576 0	....	254.15	38	....

***Sandy Hook Proving Ground, from January 17 to September 27, 1894*—Continued.**

to prove powder.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			
D, 36,417 H, 36,533	6	1	6	1	Wind from rear, 0°, 23 miles an hour; barometer, 30.11; thermometer, 46°; humidity, 45.	Shot stamped on base. 18,000 coppers of 1892 in gauge D; 24,000 coppers of 1892 in gauge H.	Gun mounted on 10-inch proof carriage. 1 quart of oil added to cylinder. Fired into sand butt No. 1. Obturating friction primers. Velocities taken by Lieut. F. P. Peck, Ordnance Department. Firing conducted by Lieut. M. F. Harmon, First Artillery.
D, 60,600 A, 62,600	....		....			Shot stamped No. 2 on base. 28,000 coppers of 1890 in gauge D; 32,000 coppers of 1892 in gauge A. The spindle broke between the spindle nut and the lock nut; the rear piece, 2 inches long, with the lock nut on it, was projected 112 feet to the rear. The breechblock was opened easily. This spindle was put in the gun between rounds 199 and 200 to replace one broken by the former round, and has therefore withstood only 18 rounds. The fracture shows good metal.	

band prepared for enlarged chamber.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Q, 35,150 U, 34,127	6	3½	6	3½	Wind left and front, 45°, 36 miles an hour; barometer, 30.47; thermometer, 60°; humidity, 68.	The band of same form as the service band, but with its diameter increased 0.1 inch. This is intended to prevent stripping and to give the normal travel of projectile. When recovered the band showed that it took the grooves as intended.	Gun mounted on 10-inch proof carriage. Obturating friction primers. Fired into sand butt No. 2. A new mushroom head and pad received and fitted before this firing. A base igniter of 2½ ounces rifle powder on each section of cartridge. 3 quarts of oil added to cylinder. The evidence regarding the action of these 2 bands is not conclusive, as another thick band fired on a later date was found in precisely the same condition as noted for the service band in round 219, so that it is doubtful whether the apparent stripping may not in both cases be due to the action of the sand in the butt, although this grinding action has not been observed to be carried to such an extent, and around the entire circumference, with any other projectile. Firing conducted by Lieut. F. P. Peck, Ordnance Department, in the presence of the testing board. Fremont P. Peck, Lieutenant, Ordnance Department, U. S. A.
Q, 34,920 U, 35,356	6	3¾	6	3¾		Service band. This particular projectile was not recovered, but another of the same kind fired a few days later was found, on which the band was entirely stripped of that portion of the metal outside the surface of the body.	

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet

[Object of firing, to test action of

Date.	No. of fire.	Powder.				Projectile.		Shot stamped.	Deflection points.	Travel of shot in bore.	Depression.
		Kind.		Weight.	Number of prisms.	Kind.	Weight.				
1894.				*Lbs. Oz.*			*Lbs. Oz.*			*Inches.*	′
Oct. 9	220	Du Pont's brown prismatic.	V. U., lot 17; density, 1.850.	122 13½ 119 13½ 5 243 0	1,279 1,243 Igniter.	Service band, lot 537.	576 0	70	....	254.05	42½
Oct. 9	221			122 13½ 119 13½ 5 243 0	1,280 1,249 Igniter.	Thick band, lot 623.	576 0	71	....	255.25	42½
Oct. 11	222		W. H., lot 4; density, 1.850.	122 13½ 119 13½ 5 243 0	1,280 1,248 Igniter.	Thick band, lot 633.	577 0	72	....	255.25	42½
Oct. 11	223			124 13½ 117 13½ 5 243 0	1,320 1,246 Igniter.	Service band, lot 537.	577 0	75	....	254.05	42½
Oct. 11	224		V. U., lot 16; density, 1.845.	111 13½ 113 13½ 5 226 0	1,202 1,211 Igniter.	Thick band, lot 623.	577 0	74	....	255.25	42½
Oct. 11	225			111 13½ 113 13½ 5 226 0	1,201 1,215 Igniter.	Service band, lot 537.	577 0	76	....	254.15	42½

[Object of firing, to test

1894.								*Left.*		*Elevation. Quad.* ° ′
Oct. 12	226	Du Pont's brown prismatic, W. H., lot 4; density, 1.850.	119 13½ 120 13½ 5 241 0	1,268 1,279 Igniter.	Service band, lot 537.	575 0	....	¼	254.15	2 31 *Sight.* 3 18
Oct. 12	227		119 13½ 120 13½ 5 241 0	1,267 1,280 Igniter.	Service band, lot 537.	575 0	....	*Right.* 1½	254.15	3 16
Oct. 12	228		119 13½ 120 13½ 5 241 0	1,270 1,279 Igniter.	Thick band, lot 623.	577 0	....	3	255.15	3 14

Arsenal, at Sandy Hook Proving Ground, from October 9, 1894, to April 5, 1895.

thick band with that of service.]

Instrumental velocity.	Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
250 feet from muzzle.	*Pounds.*	*Ft.*	*In.*	*Ft.*	*In.*			
1,859 1,872	B, 34,600 E, 33,300	6	3	6	3	Wind from left and rear, 14 miles an hour; barometer, 29.91; thermometer, 60°; humidity, 63.	....	Gun mounted on 10-inch proof carriage. Obturating friction primers. Fired into sand butt No. 1. ½ gallon of oil added to cylinder. The shot pan for the service will not fit the type gun. A base igniter of 2½ ounces rifle powder on each section of each cartridge. 32,000 coppers of 1890. Velocities taken by Lieut. F. P. Peck, Ordnance Department. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, in the presence of the testing board. Charles B. Wheeler, Lieutenant, Ordnance Department, U. S. A.
1,840 1,850	B, 35,455 E, 33,708	6	3	6	3		....	
1,938 1,937	Q, 39,836 U, 38,564	6	3½	6	3½	Wind from left and front, 12 miles an hour; barometer, 30.01; thermometer, 59°; humidity, 87.	....	
1,924 1,919	Q, 36,939 U, 36,711	6	3½	6	3½		....	
1,827 1,827	Q, 35,477 U, 34,683	6	3	6	3		....	
1,823 1,826	Q, 35,060 U, 35,200	6	3	6	3		....	

the accuracy of projectiles.]

....	B, 37,055 E, 36,000	6	3	6	3	Wind from right and rear, 20°, — miles an hour; barometer, 30.29; thermometer, 64°; humidity, 51.	Struck target 5 feet above, 17 feet left of center.	Gun mounted on 10-inch proof carriage. Obturating friction primers. Fired at 3,000-yard target. Scott sight No. 626 used. The target could not be seen from the gun at the height of the trunnion where the Scott sight was mounted because of the 13½-inch plate in the line of fire; direction was given for the first round by the open sight on top, and elevation by a quadrant. After the first round a point on the plate was used to sight on, its position having been noted at the first laying. When the projectile with service band fell so far short in round 234 it was thought that perhaps the plate had been sinking by means of the blast from the gun; but the next 3 rounds showed that this was not the case and that the
....	T, 35,564 V, 36,892	6	3	6	3		Struck 4½ feet above, 17 feet left of center.	
....	B, 40,800 E, 37,600	6	3	6	3		Struck 175 yards in front; reported over.	

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal, at

[Object of firing, to test action of

Date.	No. of fire.	Powder.				Projectile.			Shot stamped.	Deflection points.	Travel of shot in bore.	Elevation.	
		Kind.	Weight.		Number of prisms.	Kind.	Weight.						
1894.			Lbs.	Oz.			Lbs.	Oz.		Right.	Inches.	Sight. °	'
Oct. 12	229	Du Pont's brown prismatic, W. H., lot 4; density, 1.850.	119 120 241	13½ 13½ 5 0	1,270 1,280 Igniter.	Thick band, lot 623.	577	0	....	3	255.15	3	7
Oct. 12	230		119 120 241	13½ 13½ 5 0	1,268 1,278 Igniter.	Thick band, lot 623.	578	0	....	3	255.15	3	24
Oct. 12	231		119 120 241	13½ 13½ 5 0	1,269 1,280 Igniter.	Thick band, lot 623.	577	0	....	....	255.15	3	32
Oct. 12	232		119 120 241	13½ 13½ 5 0	1,267 1,279 Igniter.	Thick band, lot 623.	576	0	....	....	255.05	3	38
Oct. 12	233		119 120 241	13½ 13½ 5 0	1,268 1,278 Igniter.	Thick band, lot 623.	576	0	....	....	255.05	3	36
Oct. 12	234		119 120 241	13½ 13½ 5 0	1,268 1,278 Igniter.	Service band, lot 537.	575	0	....	1½	254.15	3	16
Oct. 12	235		119 120 241	13½ 13½ 5 0	1,268 1,278 Igniter.	Thick band, lot 623.	577	0	....	Left. 2	255.15	3	36
Oct. 12	236		119 120 241	13½ 13½ 5 0	1,269 1,279 Igniter.	Service band, lot 537.	577	0	....	Right. 1½	254.15	3	16
Oct. 12	237		119 120 241	13½ 13½ 5 0	1,269 1,279 Igniter.	Thick band, lot 623.	578	0	....	Left. 2	255.05	3	36

Sandy Hook Proving Ground, from October 9, 1894, to April 5, 1895—Continued.

thick band with that of service.]

Instrumental velocity.	Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
	Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			
....	T, 36,831 V, 34,164	6	3	6	3	Wind from right and rear, 20°, — miles an hour; barometer, 30.29; thermometer, 64°; humidity, 51.	Struck 275 yards in front. Elevating band, which had slipped to the front 4 inches during the first 8 rounds, put back in place.	projectile with service bands did not have a steady flight. The Best sight of latest design was mounted on the left trunnion, but there is so much play between the parts that it can not be used. While resting on its trunnion the telescope is not secure and the line of collimation may be deviated several minutes in any direction by a slight pressure. If the sight is taken off and then replaced it will not generally show the same point of sight. Round 237: The breechblock could not be opened after this round. An attempt was made by several men pulling on a rope attached to the rotating handle and striking blows simultaneously with a piece of scantling. It could not be opened by this means, though the handle started to rotate. It was finally opened by tapping on the translating stud with a sledge and copper drift. When it was rotated it could not be withdrawn by the translating handle, nor by using screws against the face plate through the ends of an iron bar fastened to the handle of the block. Pounding from the forward end by a heavy iron rammer (a wooden block being placed between it and the mushroom head) was also tried. The face plate was then taken off and it was found that the gear segment prevented the withdrawal of the block by not being rotated to its proper place. Two teeth were broken off of pinion No. 3 and the cut out portion of the segment had not rotated sufficiently to allow the block to pass. These teeth must have been broken in using force on the rotating handle; then afterwards rotating the block by the translating stud, permitting the rotating handle and intermediate pinions to fall behind. No cause could be found to make the block stick so hard unless it was residue around the split rings; but the locking nuts on spindle were loosened. Firing conducted by Lieut. F. P. Peck, Ordnance Department, in the presence of the testing board. Present: Maj. I. Arnold, jr., Ordnance Department; Maj. J. W. Reilly, Ordnance Department; Capt. F. Heath, Ordnance Department; Lieut. F. P. Peck, Ordnance Department.
....	B, 37,800 E, 37,018	6	3	6	3		Struck 50 yards in front and 10 feet to the right of target.	
....	T, 37,018 V, 34,600	6	3	6	3		Struck 18 yards in front.	
....	B, 35,963 E, 39,178	6	3	6	3		Struck target 7 feet above, 4 feet right of center.	
....	T, 37,127 V, 36,156	6	3	6	3		Struck target 2 feet below, 18 feet right of center.	
....	J, 36,969 O, 35,486	6	3	6	3		Struck near 2,000 yards bombproof, ricochetted over target, and fell in the woods near the Shrewsbury River, about 2 miles farther on.	
....	T, 38,436 V, 37,036	6	3	6	3		Struck target 2 feet left of center.	
....	J, 36,333 O, 34,800	6	3	6	3		Struck 200 yards in front.	
....	T, 35,800 V, 32,000	6	3	6	3		Struck target 4 feet above center.	

Record of firing with 10-inch B. L. rifle (steel), No 1, type, Watervliet Arsenal, at

[Object of firing, to test

Date.	No. of fire.	Powder.			Projectile.		Shot stamped.	Deflection points.	Travel of shot in bore.	Elevation.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
1895.			*Lbs. Oz.*			*Lbs. Oz.*			*Inches.*	*Quad.* ° ′
Mar. 29	238	Du Pont's brown prismatic, V. U.; lot 9.	129 13½ 129 13½ 5 260 0	1,340 1,323 Igniter.	Shot, lot 623, thick band.	578 0	....	....	254.75	0 55
Mar. 29	239		134 13½ 134 13½ 5 270 0	1,389 1,393 Igniter.		578 0	....	....	254.75	1 5
										Depression. ′
Apr. 4	240		129 13½ 127 13½ 5 258 0	1,342 1,322 Igniter.		574 0	....	....	254.65	32½
Apr. 4	241		129 13½ 127 13½ 5 258 0	1,342 1,319 Igniter.		574 0	....	....	254.65	32½
Apr. 4	242		134 13½ 134 13½ 5 270 0	1,393 1,393 Igniter.		578 0	....	....	254.55	32½
Apr. 4	243		133 13½ 140 13½ 5 275 0	1,384 1,454 Igniter.		577 0	....	....	254.85	32½
Apr. 5	244		139 13½ 139 13½ 5 280 0	1,445 1,444 Igniter.		580 8	....	....	254.75	32½

Sandy Hook Proving Ground, from October 9, 1894, to April 5, 1895—Continued.

gun for accuracy at one mile.]

Instrumental velocity.	Pressure per square inch of bore.	Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
250 feet from muzzle.	*Pounds.*	*Ft. In.*	*Ft. In.*			
....	B, 32,244 E, 34,000	6 8	......	....	3¼ small points to the right. Elevation on wheel, 3.5.	Gun mounted on 10-inch proof carriage. Obturating friction primers. The gun has a preponderance in front, so that it undoubtedly is depressed by the motion of the projectile in the bore. The elevating apparatus was broken, and a rope was put on breech and secured to top carriage; but this allowed too much movement of the gun for accurate shooting, and the firing was discontinued. Aimed at the center of bull's-eye. The vent had to be reamed out before firing. The new locking device for rotating handle fitted before round 243. The gun was washed out and examined after each round. Before firing, April 4, a new tie rod put over the breech to hold gun down with turn buckles on. Fired into sand butts.
....	I, 35,356 T, 33,737	6 4	......	....	Tray latch would not hold, due to spring catch.	
1,879 1,883	I, 31,400 T, 31,200	6 2	......	....	....	
1,911 1,910	I, 34,900 T, 32,169	6 3	......	....	....	
1,950 1,950	I, 36,080 T, 33,266	6 4	......	....	....	
1,952 1,945	I, 36,140 T, 35,356	6 3	......	....	....	
.... 200+1½°	B, 40,556 E, 87,733	6 4	......	....	The left chassis rail cracked along the inside for about 3 feet.	

Record of firing with 10-inch B. L. rifle (steel), No 1, type, Water-

[Object of firing, to test

Date.	No. of fire.	Powder.				Projectile.			Travel of shot in bore.	Elevation by Scott sight on wheel.	Elevation, quadrant.		Deflection, left.	Pressure per square inch of bore.
		Kind.	Weight.		Number of prisms.	Kind.	Weight.							
1895.			*Lbs.*	*Oz.*			*Lbs.*	*Oz.*	*Inches.*	′	°	′	*Points.*	*Pounds.*
Aug. 10	245	Du Pont's brown prismatic, V. U., lot 19.	119 139 260	13½ 13½ 5 0	1,234 1,444 Igniter.	Solid shot, lot 648, large band.	577	0	254.85	60	1	27	8½	O, 33,550 P, 34,683
Aug. 10	246		119 139 260	13½ 13½ 5 0	1,232 1,446 Igniter.		578	0	254.85	57	1	25	....	O, 33,818 P, 33,020
Aug. 10	247		119 139 260	13½ 13½ 5 0	1,233 1,245 Igniter.		578	0	254.85	57	1	25	....	O, 37,360 P, 37,055
Aug. 10	248		119 139 260	13½ 13½ 5 0	1,233 1,245 Igniter.		578	0	254.85	57	1	26	....	O, 34,635 P, 34,667
Aug. 10	249		119 139 260	13½ 13½ 5 0	1,234 1,244 Igniter.		577	8	254.85	57	1	27	....	O, 35,545 P, 34,036
Aug. 10	250		119 139 260	13½ 13½ 5 0	1,234 1,446 Igniter.		578	0	254.85	57	1	27	....	O, 34,973 P, 35,000

vliet Arsenal, at Sandy Hook Proving Ground, August 10, 1895.

accuracy of gun at 1 mile.]

Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.								General remarks.
					TARGET.								
					From center of target.				From center of impact.				
					Vertical.		Horizontal.		Vertical.		Horizontal.		
Ft.	*In.*	*Ft.*	*In.*		Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.	
					Ft.	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	
6	3½	6	3½	Wind from left and front, 35°, 6 miles an hour; barometer, 30.14; thermometer, 84°; humidity, 80.	Sighting shot. Struck 150 yards beyond. Rod attached to front transom, holding elevating screw, bent.								
6	3	6	3		....	6.75	....	7	....	2.6	0.2	....	Gun mounted on 10-inch proof carriage. Obturating friction primers. The tray latch failed to hold the console when the block was being closed, in each round. 32,000 coppers of 1890. The target was not visible from the gun. The gun was aimed at a point on butt No. 2. Plane of fire not obtained. Firing conducted by Lieut. W. S. Peirce, Ordnance Department, in the presence of the board for testing rifled cannon. Present: Maj. F. H. Phipps, Ordnance Department; Lieut. W. S. Peirce, Ordnance Department. W. S. Peirce, Lieutenant, Ordnance Department, U. S. A.
6	3	6	3		0.5	....	....	7	4.65	....	.2	....	
6	3	6	3		....	4	....	8	.15	....	....	0.8	
6	3	6	3		....	5.5	....	8	....	1.35	....	.8	
6	3	6	3		....	5	....	6	....	.85	1.2	....	
					Center of impact: Feet. Below .... 4.15 Left .... 7.2 Mean vertical deviation from center of impact .... 1.92 Mean horizontal deviation from center of impact .... .64 Mean deviation from center of impact 2.02								

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal,

[Object of firing,

Date.	No. of fire.	Powder.				Projectile.		Observed time of flight.	Travel of shot in bore.	Elevation.		Pressure per square inch of bore.
		Kind.	Weight.		Number of prisms.	Kind.	Weight.					
1895.			*Lbs.*	*Oz.*			*Pounds.*	"	*Inches.*	°	'	*Pounds.*
Sept. 25	251	Du Pont's brown prismatic, V. U., lot 19.	129 129 260	13½ 13½ 5 0	1,328 1,330 Igniter.	Shot, lot 587, large band.	579	....	255.15	15	0	H, 38,840 J, 38,788
Sept. 25	252		129 129 260	13½ 13½ 5 0	1,330 1,331 Igniter.		577	30½	255.15	15	0	I, 36,640 K, 39,620
Sept. 25	253		129 129 260	13½ 13½ 5 0	1,327 1,328 Igniter.		578	31	255.15	15	0	H, 40,420 J, 38,711
Sept. 25	254		129 129 260	13½ 13½ 5 0	1,327 1,328 Igniter.		577	31	255.15	15	0	K, 39,820 O, 39,260
Sept. 25	255		129 129 260	13½ 13½ 5 0	1,328 1,329 Igniter.		577	....	255.15	15	0	H, 40,022 J, 40,920
Sept. 25	256		127 129 258	13½ 13½ 5 0	1,311 1,332 Igniter.		577	....	255.15	5	0	K, 39,964 O, 38,444
Sept. 25	257		127 129 258	13½ 13½ 5 0	1,311 1,329 Igniter.		577	....	255.15	5	0	H, 39,100 J, 39,620
Sept. 25	258		127 129 258	13½ 13½ 5 0	1,307 1,329 Igniter.		577	11	255.15	5	0	K, 39,640 O, 39,520
Sept. 25	259		127 129 258	13½ 13½ 5 0	1,307 1,329 Igniter.		577	11	255.15	5	0	J, 39,460 K, 39,420
Sept. 25	260		127 129 258	13½ 13½ 5 0	1,311 1,329 Igniter.		577	11	255.15	5	0	K, 39,560 O, 39,500

at Sandy Hook Proving Ground, from September 25, 1895, to January 29, 1896.

to obtain range.]

Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.					General remarks.
					TARGET.					
					Range.	From center of impact.				
						Longitudinal.		Lateral.		
						+	—	Right.	Left.	
Ft.	*In.*	*Ft.*	*In.*		*Yards.*	*Yards.*	*Yards.*	*Yards.*	*Yards.*	
4	0	....		Wind from front, 13 miles an hour; barometer, 30.25; thermometer, 73°; humidity, 65.	11,483	36.2	....	9.8	....	Gun mounted on 10-inch barbette carriage. Obturating friction primers. Fired to sea. Scott sight used for direction and quadrant for elevation. Gun washed out and examined after each shot. Yards. Greatest range .... 11,680 Least range .... 11,230 Dispersion in range ... 450 Lateral dispersion..... 53 Mean range .... 11,446.8 Mean longitudinal deviation from center of impact .... 129.84 Mean lateral deviation from center of impact 16.56
4	0	3	9		11,502	55.2	....	1.8	....	
4	0	3	11		11,230	....	216.8	29.8	....	
4	0	4	0		11,339	....	107.8	....	18.2	
4	0	4	0		11,680	233.2	....	....	23.2	
4	0	4	0		6,449	88.4	....	5.6	....	Yards. Greatest range.......... 6,449 Least range .... 6,990 Dispersion in range.... 159 Lateral dispersion...... 16 Mean range .... 6,360.6 Mean longitudinal deviation from center of impact .... 55.68 Mean lateral deviation from center of impact. 4.72
4	0	4	0		6,387	26.4	....	....	1.4	
4	0	4	0		6,292	....	68.6	....	10.4	
4	0	4	0		6,385	24.4	....	1.6	....	
4	0	4	0		6,290	....	70.6	4.6	....	

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal, at Sandy

[Object of firing.

Date.	No. of fire.	Powder. Kind.	Powder. Weight. Lbs.	Powder. Weight. Oz.	Powder. Number of prisms.	Projectile. Kind.	Projectile. Weight.	Observed time of flight.	Travel of shot in bore.	Elevation. °	Elevation. ′	Pressure per square inch of bore.
			Lbs.	*Oz.*			*Pounds.*	″	*Inches.*	°	′	*Pounds.*
1895. Sept. 25	261	Du Pont's brown prismatic, V. U., lot 19.	125 129	13½ 13½ 5	1,290 1,329 Igniter.	Shot, lot 537, large band.	577	20	255.15	10	0	K, 39,560 O, 39,500
			256	0								
Sept. 25	262		125 129	13½ 13½ 5	1,290 1,330 Igniter.		577	21	255.05	10	0	H, 38,178 J, 38,689
			256	0								
Sept. 25	263		125 129	13½ 13½ 5	1,290 1,329 Igniter.		577	20¾	255.05	10	0	K, 38,289 O, 38,422
			256	0								
Sept. 25	264		125 129	13½ 13½ 5	1,290 1,329 Igniter.		577	21	255.05	10	0	H, 38,222 J, 38,467
			256	0								
Sept. 25	265		125 129	13½ 13½ 5	1,290 1,329 Igniter.		576	Lost.	255.15	10	0	K, 40,960 O, 41,089
			256	0								
Oct. 18	266		130 129	13½ 13½ 5	1,352 1,342 Igniter.		576	....	254.95	10	0	K, 37,489 O, 39,060
			261	0								
Oct. 18	267	Du Pont's brown prismatic, V. U., lot 15.	112 111	13½ 13½ 5	1,188 1,178 Igniter.		578	....	255.05	10	0	H, 36,620 J, 36,511
			225	0								
Oct. 18	268		111 112	13½ 13½ 5	1,178 1,188 Igniter.		578	....	255.05	10	0	J, 36,960 P, 34,700
			225	0								
1896. Jan. 16	269	V. U., 2 V. U., 14 P., 7 W.H., 7 W.H., 6 P., 7	35 29 5 8 20 41	0 13½ 0 0 0 13½ 5	752 729		576	....	254.95	5	0	J, 16,963 K, 16,545
			140	0								

Hook Proving Ground, from September 25, 1895, to January 29, 1896—Continued.

to obtain range.]

Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.					General remarks.
			TARGET.					
			Range.	From center of impact.				
				Longitudinal.		Lateral.		
				+	−	Right.	Left.	
Ft. In.	*Ft. In.*		*Yards.*	*Yards.*	*Yards.*	*Yards.*	*Yards.*	
4 0	4 0	Wind from front, 13 miles an hour; barometer, 30.25; thermometer, 73°; humidity, 65.	8,768	107.6	....	2.4	....	Yards. Greatest range .... 8,768 Least range .... 8,552 Dispersion in range .. 216 Lateral dispersion.... 28 Mean range .... 8,660.4 Mean longitudinal deviation from center of impact............ 68.08 Mean lateral deviation from center of impact................. 8.24 Impressions taken after round 265. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
4 0	4 0		8,627	....	33.4	7.4	....	
4 0	4 0		8,632	....	28.4	....	20.6	
4 0	4 0		8,552	....	108.4	6.4	....	
4 0	4 0		8,723	62.6	....	4.4	....	
4 0	4 0	Wind from rear, 12 miles an hour; barometer, 30.20; thermometer, 46°; humidity, 72.	....					Fired to sea. Firing conducted by Lieut. W. S. Peirce, assistant proof officer.
4 0	4 0		....					
4 0	4 0		Rope stranded in hoisting shot.......					
....	....	Wind from front, 9 miles an hour; barometer, 30.60; thermometer, 33°; humidity, 70.	....					

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal, at Sandy

[Object of firing,

Date.	No. of fire.	Powder.				Projectile.		Observed time of flight.	Travel of shot in bore.	Elevation.		Pressure per square inch of bore.
		Kind.	Weight.		Number of prisms.	Kind.	Weight.					
1896.			*Lbs.*	*Oz.*			*Pounds.*	*″*	*Inches.*	°	′	*Pounds.*
Jan. 16	270	Du Pont's brown prismatic, V. U., lot 22.	129 129 260	13½ 13½ 5 0	1,335 1,334 Igniter.	Shot, lot 537, large band.	576	....	255.05	5	0	J, 34,489 K, 34,920
Jan. 16	271		129 129 260	13½ 13½ 5 0	1,335 1,335 Igniter.		576	10¾	255.15	5	0	H, 36,690 I, 33,855
Jan. 16	272		129 129 260	13½ 13½ 5 0	1,335 1,335 Igniter.		576	11	255.15	5	0	J, 34,489 K, 35,000
Jan. 16	273		129 129 260	13½ 13½ 5 0	1,337 1,335 Igniter.		576	11	255.15	5	0	H, 35,620 I, 33,440
Jan. 16	274		129 129 260	13½ 13½ 5 0	1,335 1,335 Igniter.		576	10¾	255.15	5	0	J, 33,945 K, 34,356
Jan. 16	275		129 129 260	13½ 13½ 5 0	1,335 1,335 Igniter.		576	10¾	255.15	5	0	H, 35,111 I, 32,340
Jan. 16	276		129 129 260	13½ 13½ 5 0	1,335 1,335 Igniter.		575	10¾	255.15	5	0	J, 33,360 K, 33,540
Jan. 16	277		129 129 260	13½ 13½ 5 0	1,335 1,335 Igniter.		575	10¾	255.15	5	0	H, 35,000 I, 33,360
Jan. 16	278		129 129 260	13½ 13½ 5 0	1,338 1,338 Igniter.	Solid shot, lot 537.	576	11	255.15	5	0	J, 34,378 K, 35,356
Jan. 16	279		129 129 260	13½ 13½ 5 0	1,338 1,338 Igniter.		576	11	255.15	5	0	H, 35,533 I, 32,280
Jan. 16	280		129 129 260	13½ 13½ 5 0	1,338 1,338 Igniter.	Solid shot, lot 502.	576	....	255.15	5	0	J, 32,100 K, 32,620
Jan. 16	281		134 129 265	13½ 13½ 5 0	1,391 1,338 Igniter.		576	....	255.15	10	0	J, 34,156 K, 32,909

Hook Proving Ground, from September 25, 1895, to January 29, 1896—Continued.

to obtain range.]

Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.						General remarks.
Ft. In.	*Ft. In.*								
....	....	Wind from front, 9 miles an hour; barometer, 30.60; thermometer, 33°; humidity, 70.	....						
			TARGET.						
			Range.	Deviation, right.	From center of impact.				
					Longitudinal.		Lateral.		
					+	−	Right.	Left.	
			Yards.	*Yds.*	*Yds.*	*Yds.*	*Yds.*	*Yds.*	
....	....		5, 243. 17	13. 421	48. 284	......	.....	3. 315	Gun mounted on 10-inch barbette carriage. Obturating friction primers. Fired to sea. Aimed by Scott sight No. 627. at a small target about 1 foot square, planted about 500 feet from gun. Gun washed out and examined after each round. Round 274: The rope of shot hoist stranded. Yards. Greatest range......... 5, 248. 62 Least range............ 5, 151. 68 Dispersion in range ... 96. 94 Greatest deviation.... 24. 521 Least deviation .... 12. 219 Lateral dispersion .... 12. 302 Mean range .... 5, 194. 886 Mean deviation .... 16. 736 Mean longitudinal de deviation from the center of impact .... 27. 837 Mean lateral deviation from center of impact 2. 641 Center of impact...... 27. 962 Mean deviation from plane of fire......... 16. 726 Firing conducted by Lieut. W. S. Peirce, Ordnance Department, assistant proof officer.
....	....		5, 192. 07	16. 915	......	2. 816	0. 179	......	
....	....		5, 248. 62	21. 883	53. 734	......	5. 147	......	
....	....		5, 208. 94	24. 521	14. 054	......	7. 785	......	
....	....		5, 151. 68	16. 784	......	43. 206	. 048	......	
....	....		5, 151. 68	16. 784	......	43. 206	. 048	......	
....	....		5, 166. 86	15. 731	......	28. 026	....	1. 005	
4 0	4 0		5, 183. 92	14. 551	......	10. 966	.....	2. 185	
4 0	4 0		5, 183. 92	14. 551	......	10. 966	.....	2. 185	
4 0	4 0		5, 218. 00	12. 219	23. 114	......	.....	4. 517	
4 0	4 0		....						

Record of firing with 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal, at Sandy

[Object of firing, to test

Date.	No. of fire.	Powder.			Projectile.		Observed time of flight.	Travel of shot in bore.	Elevation.	Pressure per square inch of bore.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
			Lbs. Oz.			*Pounds.*		*Inches.*	*Quad.* ° '	*Pounds.*
1896. Jan. 29	282	Du Pont's brown prismatic, V. U., lot 22.	139 13½ 129 13½ 5 270 0	1,438 1,336 Igniter.	Rebanded.	574	....	255.15	2 30	J, 33,400 K, 35,760
Jan. 29	283		139 13½ 129 13½ 5 270 0	1,440 1,338 Igniter.	Solid shot, lot 502.	576	....	255.15	2 31	H, 36,720 P, 37,200
Jan. 29	284		134 13½ 134 13½ 5 270 0	1,391 1,393 Igniter.		576	....	255.15	2 31	J, less than 32,000 K, 35,222
Jan. 29	285		129 13½ 139 13½ 5 270 0	1,338 1,440 Igniter.		576	....	255.10	2 31	H, 36,620 P, 37,022
Jan. 29	286		129 13½ 139 13½ 5 270 0	1,339 1,439 Igniter.		579	....	255.10	2 31	I, 34,940 K, 35,533
Jan. 29	287		134 13½ 134 13½ 5 270 0	1,391 1,392 Igniter.		576	....	255.15	2 31	H, 37,044 P, 36,960
Jan. 29	288		134 13½ 134 13½ 5 270 0	1,391 1,391 Igniter.		576	....	255.10	2 31	I, 33,818 K, 36,022
Jan. 29	289		134 13½ 134 13½ 5 270 0	1,391 1,393 Igniter.		578	....	254.95	2 31	H, 37,067 P, 33,960
Jan. 29	290		134 13½ 134 13½ 5 270 0	1,392 1,392 Igniter.		579	....	254.95	2 31	I, 34,156 K, 36,422
Jan. 29	291		134 13½ 134 13½ 5 270 0	1,391 1,393 Igniter.		580	....	254.95	2 31	H, 35,760 P, 36,178
Jan. 29	292		134 13½ 134 13½ 5 270 0	1,392 1,392 Igniter.		580	....	255.10	2 31	H, 36,720 P, 36,620

Hook Proving Ground, from September 25, 1895, to January 29, 1896—Continued.

accuracy at 3,000 yards.]

Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.									General remarks.
Ft.	*In.*	*Ft.*	*In.*											
3	8	3	7	Wind from front and left, 20°; barometer, 30.38; thermometer, 40°; humidity, 76.	....									Gun mounted on 10-inch barbette carriage. Obturating friction primers. Fired at 3,000-yard target aimed. The two screws of the dust guard to the right and next to the front clip are broken. Round 283: Two links were removed from the sprocket chain. Round 288: All holding-down bolts tightened; there are indications of a slight movement of face plate on foundation. Red serge igniter used on forward section of cartridge and a double thickness of Swiss muslin on the last section. Center of impact: Feet. Below .... 12.3 Left .... 15.383 Mean vertical deviation from center of impact.. 1.44 Mean horizontal deviation from center of impact.. 2.607 Mean deviation from center of impact .... 2.978 Mean deviation from plane of fire 14.217
					[Target by marks on carriage.]									
					Wind, miles per hour.	From center of target.				From center of impact.				
						Vertical.		Horizontal.		Vertical.		Horizontal.		
						Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.	
3	8	3	7		7	...	10.5	...	12	1.8	....	3.383	.....	
3	8	3	8		6	...	10.5	...	12.25	1.8	....	3.133	.....	
3	9	3	9		7	...	13	...	16.66	....	0.7	.....	1.283	
3	9	3	9		9	...	13.5	...	17	....	1.2	.....	1.617	
3	9	3	9		12	...	14	...	19	....	1.7	.....	3.617	
					[Target by Scott sight alone.]									
3	9	3	9		10	...	13.5	...	14.25	....	.75	.125	.....	Center of impact: Feet. Below .... 12.75 Left .... 14.375 Mean vertical deviation from center of impact.. 0.75 Mean horizontal deviation from center of impact.. 0.125 Mean deviation from center of impact .... 0.760 Mean deviation from plane of fire .... 15.225 Firing conducted by Lieut. W. S. Peirce, Ordnance Department, in the presence of the Board for Testing Rifled Cannon. For the Board: Isaac Arnold, jr., Major, Ordnance Department, U. S. A., president.
3	9	3	9		10	Struck 25 yards in front.								
3	9	3	9		10	...	12	...	14.5	0.75	....	.....	.125	
3	9	3	9		10	Struck 19 yards in front.								
3	9	3	9		10	Struck 75 yards in front.								

Star gauging of 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal, at Sandy Hook Proving Ground.

LANDS.

[9.99845-inch ring and 10-inch points.]

Inches from muzzle.	Before firing, Sept. 16, 1890.	After 64 rounds, Feb. 23, 1892.	Increase.	After 130 rounds, July 21, 1892.	Increase.	After 190 rounds, May 19, 1893.	Increase.	After 217 rounds, April 26, 1894.	Increase.	After 244 rounds, June 18, 1895.	Increase.	After 292 rounds, Feb. 8, 1896.	Increase.	Total increase.
	Inches.	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inch.*
0		10.0050		10.0060	.0010			10.0095		10.0125	.0030	10.0105	—.0020	
5		10.0030		10.0050	.0020			10.0060		10.0055	—.0005	10.0065	.0010	
10		10.0040		10.0040	.0000	10.0060	.0020	10.0055	—.0005	10.0055	.0000	10.0060	.0005	
15		10.0030		10.0030	.0000	10.0050	.0020	10.0055	.0005	10.0045	—.0010	10.0045	.0000	
20		10.0040		10.0040	.0000	10.0060	.0020	10.0060	.0000	10.0055	—.0005	10.0055	.0000	
25		10.0040		10.0040	.0000	10.0060	.0020	10.0070	.0010	10.0060	—.0010	10.0055	—.0005	
30		10.0040		10.0040	.0000	10.0070	.0030	10.0070	.0000	10.0055	—.0015	10.0065	.0010	
35		10.0040		10.0040	.0000	10.0070	.0030	10.0065	—.0005	10.0055	—.0010	10.0055	.0000	
40		10.0040		10.0040	.0000	10.0070	.0030	10.0070	.0000	10.0055	—.0015	10.0055	.0000	
45		10.0040		10.0050	.0010	10.0070	.0020	10.0070	.0000	10.0065	—.0005	10.0065	.0000	
50		10.0040		10.0050	.0010	10.0070	.0020	10.0075	.0005	10.0075	.0000	10.0065	—.0010	
55		10.0040		10.0050	.0010	10.0075	.0025	10.0070	—.0005	10.0075	.0005	10.0065	—.0010	
60		10.0040		10.0040	.0000	10.0080	.0040	10.0065	—.0015	10.0065	.0000	10.0065	.0000	
65		10.0050		10.0060	.0010	10.0090	.0030	10.0085	—.0005	10.0095	.0010	10.0075	—.0020	
70		10.0050		10.0060	.0010	10.0090	.0030	10.0075	—.0015	10.0085	.0010	10.0065	—.0020	
75		10.0050		10.0050	.0000	10.0090	.0040	10.0075	—.0015	10.0085	.0010	10.0065	—.0020	
80		10.0050		10.0060	.0010	10.0095	.0035	10.0085	—.0010	10.0095	.0010	10.0085	—.0010	
85		10.0050		10.0060	.0010	10.0095	.0035	10.0085	—.0010	10.0105	.0020	10.0095	—.0010	
90		10.0060		10.0060	.0000	10.0100	.0040	10.0095	—.0005	10.0095	.0000	10.0105	.0010	
95		10.0060		10.0060	.0000	10.0100	.0040	10.0095	—.0005	10.0095	.0000	10.0105	.0010	
100		10.0060		10.0060	.0000	10.0100	.0040	10.0095	—.0005	10.0105	.0010	10.0105	.0000	
105		10.0060		10.0060	.0000	10.0100	.0040	10.0100	.0000	10.0105	.0005	10.0105	.0000	
110		10.0060		10.0060	.0000	10.0100	.0040	10.0100	.0000	10.0105	.0005	10.0115	.0010	
115		10.0060		10.0060	.0000	10.0100	.0040	10.0105	.0005	10.0105	.0000	10.0110	.0005	
120		10.0070		10.0060	—.0010	10.0100	.0040	10.0100	.0000	10.0105	.0005	10.0115	.0010	
125		10.0070		10.0070	.0000	10.0105	.0035	10.0105	.0000	10.0105	.0000	10.0115	.0010	
130		10.0060		10.0060	.0000	10.0105	.0045	10.0105	.0000	10.0105	.0000	10.0125	.0020	
135		10.0060		10.0060	.0000	10.0105	.0045	10.0105	.0000	10.0105	.0000	10.0145	.0030	
140		10.0070		10.0070	.0000	10.0110	.0040	10.0115	.0005	10.0115	.0000	10.0135	.0020	
145		10.0070		10.0080	.0010	10.0135	.0055	10.0135	.0000	10.0135	.0000	10.0155	.0020	
150		10.0070		10.0070	.0000	10.0115	.0045	10.0125	.0010	10.0125	.0000	10.0165	.0040	
155		10.0070		10.0060	—.0010	10.0100	.0040	10.0130	.0030	10.0125	—.0005	10.0175	.0050	
160	10.0050	10.0070	.0020	10.0070	.0000	10.0115	.0045	10.0135	.0020	10.0135	.0000	10.0185	.0050	.0185
165		10.0060		10.0080	.0020	10.0130	.0050	10.0140	.0010	10.0165	.0025	10.0215	.0050	
170		10.0060		10.0070	.0010	10.0130	.0060	10.0185	.0005	10.0155	.0020	10.0245	.0090	
175		10.0070		10.0070	.0000	10.0145	.0075	10.0150	.0005	10.0175	.0025	10.0265	.0090	
180	10.0040	10.0070	.0030	10.0070	.0000	10.0150	.0080	10.0185	.0035	10.0215	.0030	10.0345	.0130	.0305

185	....	10.0070	....	10.0070	.0000	10.0150	.0080	10.0235	.0085	10.0255	.0020	(*a*)	(*a*)	(*a*)
190	....	10.0080	....	10.0080	.0000	10.0170	.0090	10.0275	.0105	10.0295	.0020	....	....	....
195	....	10.0080	....	10.0090	.0010	10.0190	.0100	10.0335	.0145	10.0335	.0000	....	....	....
200	10.0040	10.0090	.0050	10.0100	.0010	10.0200	.0100	10.0375	.0175	10.0385	.0010	....	....	....
205	....	10.0080	....	10.0110	.0030	10.0230	.0120	10.0415	.0185	10.0445	.0030	....	....	....
210	....	10.0100	....	10.0130	.0030	10.0255	.0125	10.0435	.0180	10.0485	.0050	....	....	....
215	....	10.0160	....	10.0220	.0060	10.0390	.0170	10.0555	.0165	10.0675	.0120	....	....	....
220	10.0160	10.0260	.0100	10.0320	.0060	10.0485	.0165	10.0795	.0310	10	(*b*)	....	....	....
222	10.0190	10.0280	.0090	10.0360	.0080	10.0570	.0210	10.1035	.0465	10	....	....	....	....
224	10.0220	10.0310	.0090	10.0400	.0090	10.0575	.0175	10.1385	.0810	10	....	....	....	....
226	10.0230	10.0340	.0110	10.0430	.0090	10.0605	.0175	10.1425	.0820	10	....	....	....	....
228	10.0260	10.0380	.0120	10.0470	.0090	10.0680	.0210	10.1445	.0765	10	....	....	....	....
230	10.0310	10.0420	.0110	10.0520	.0100	10.0750	.0230	10.1465	.0715	10	....	....	....	....
232	10.0330	10.0460	.0130	10.0590	.0130	10.0780	.0190	10.1605	.0825	10	....	....	....	....
234	10.0360	10.0500	.0140	10.0630	.0130	10.0845	.0215	10.1645	.0800	(*b*)	....	....	....	....
236	10.0390	10.0550	.0160	10.0690	.0140	10.0900	.0210	10.1625	.0725	....	....	....	....	....
238	10.0440	10.0600	.0160	10.0740	.0140	10.0960	.0220	10.1675	.0715	....	....	....	....	....
240	10.0450	10.0640	.0190	10.0790	.0150	10.1020	.0230	10.1745	.0725	....	....	....	....	....
242	10.0480	10.0690	.0210	10.0850	.0160	10.1110	.0260	10.1665	.0555	....	....	....	....	....
244	10.0530	10.0750	.0220	10.0920	.0170	10.1140	.0220	10.1685	.0545	....	....	....	....	....
246	10.0560	10.0800	.0240	10.0980	.0180	10.1370	.0390	10.1765	.0395	....	....	....	....	....
248	10.0590	10.0840	.0250	10.1040	.0200	10.1260	.0220	10.1835	.0575	....	....	....	....	....
250	10.0620	10.0910	.0290	10.1130	.0220	10.1320	.0190	10.1905	.0585	....	....	....	....	....

a No contact after 180 inches.

b No contact after 215 inches.

The bore is very much **eroded and scored.** **Beginning** from about the middle of the length of the chamber, where **the surface begins to be rough, the scoring gradually** increases in depth to the beginning of rifling, where it is the deepest for about 1 caliber in length; along here the surface is very uneven and ragged, and the lands are almost indistinguishable from the grooves. The scoring is noticeably worse on the top half than on the bottom, and a little worse on the left than on the right.

At the left extremity of the horizontal diameter there is a wide and irregular furrow about 7 inches long and ¾ inch wide at the widest part. At the other extremity of the same diameter there is another furrow somewhat less noticeable. These two are the most pronounced, but there are also on top several narrower furrows that look like cracks from the breech, varying in length from 1 to 6 or 7 inches, and in some places from ¼ to ⅓ inch in width.

From the impressions these furrows seem to have a maximum depth of about ¼ inch below the general surface, but the deepest parts are smooth, as if there were no real cracks in the tube. From this point of the bore forward, the furrows become gradually less apparent for about 8 calibers, when the surface of the bore is again comparatively **smooth.** Owing to the unevenness of the scored part of the bore it is impossible to get good contact with the star gauge points, and the readings only give the approximate **diameters**

Star gauging of 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal, at Sandy Hook Proving Ground—Continued.

CHAMBER VERTICAL.

[11.8-inch ring and points.]

Inches from breech.	After 64 rounds, Feb. 23, 1892.	After 190 rounds, May 19, 1893.	Increase.	After 217 rounds, Apr. 26, 1894.	Increase.	After 244 rounds, June 17, 1895.	Increase.	Total increase after 244 rounds.	After 292 rounds, Feb. 8, 1896.	Increase.	Total increase.
	Inches.	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inch.*	*Inches.*	*Inch.*	*Inch.*
24	11.8040	11.7995	—.0045	11.8060	.0065	11.8050	—.0010	.0010	11.8060	.0010	.0020
26	11.8000	11.7995	—.0005	11.8030	.0035	11.8030	.0000	.0030	11.8040	.0010	.0040
28	11.7980	11.7975	—.0005	11.8020	.0045	11.8010	—.0010	.0030	11.8020	.0010	.0040
30	11.7980	11.7960	—.0020	11.8000	.0040	11.8005	.0005	.0025	11.8000	—.0005	.0020
32	11.7980	11.7970	—.0010	11.8000	.0030	11.8000	.0000	.0020	11.8000	.0000	.0020
34	11.7980	11.7965	—.0015	11.7990	.0025	11.8000	.0010	.0020	11.8000	.0000	.0020
36	11.7980	11.7965	—.0015	11.8000	.0035	11.8000	.0000	.0020	11.8000	.0000	.0020
38	11.7980	11.7965	—.0015	11.8005	.0040	11.8010	.0005	.0030	11.8010	.0000	.0030
40	11.7990	11.7970	—.0020	11.8010	.0040	11.8015	.0005	.0025	11.8020	.0005	.0030
42	11.8000	11.7980	—.0020	11.8010	.0030	11.8020	.0010	.0020	11.8020	.0000	.0020
44	11.8000	11.7995	—.0005	11.8010	.0015	11.8025	.0015	.0025	11.8030	.0005	.0030
46	11.8000	11.8005	.0005	11.8015	.0010	11.8035	.0020	.0035	11.8040	.0005	.0040
48	11.8000	11.8000	.0000	11.8005	.0005	11.8035	.0030	.0035	11.8040	.0005	.0040
50	11.8010	11.8005	—.0005	11.8030	.0025	11.8045	.0015	.0035	11.8060	.0015	.0050
52	11.8000	11.8000	.0000	11.8020	.0020	11.8040	.0020	.0040	11.8060	.0020	.0060
54	11.8010	11.8015	.0005	11.8035	.0020	11.8050	.0015	.0040	11.8100	.0050	.0090
56	11.8010	11.8030	.0020	11.8040	.0010	11.8065	.0025	.0055	11.8110	.0045	.0100
58	11.8020	11.8040	.0020	11.8070	.0030	11.8095	.0025	.0075	11.8170	.0075	.0150
60	11.8030	11.8050	.0020	11.8085	.0035	11.8120	.0035	.0090	11.8190	.0070	.0160
62	11.8030	11.8060	.0030	11.8090	.0030	11.8150	.0060	.0120	11.8200	.0050	.0170
64	11.8030	11.8070	.0040	11.8090	.0020	11.8150	.0060	.0120	11.8210	.0060	.0180
66	11.8050	11.8080	.0030	11.8120	.0040	11.8150	.0030	.0100	11.8250	.0100	.0200
68	11.8040	11.8100	.0060	11.8120	.0020	11.8130	.0010	.0090	11.8280	.0150	.0240
70	11.8040	11.8105	.0065	11.8135	.0030	11.8200	.0065	.0160	11.8300	.0100	.0260
72	11.8060	11.8140	.0080	11.8195	.0055	11.8270	.0075	.0210	11.8380	.0110	.0320
74	11.8060	11.8140	.0080	11.8215	.0075	11.8280	.0065	.0220	11.8410	.0130	.0350
76	11.8060	11.8180	.0120	11.8240	.0060	11.8340	.0100	.0280	11.8470	.0130	.0410
78	11.8080	11.8200	.0120	11.8295	.0095	11.8390	.0095	.0310	11.8520	.0130	.0440
80	11.8070	11.8205	.0135	11.8265	.0060	11.8360	.0095	.0290	11.8550	.0190	.0480

185	....	10.0070	....	10.0070	.0000	10.0150	.0080	10.0235	.0085	10.0255	.0020	(a)	(a)	(a)
190	....	10.0080	....	10.0080	.0000	10.0170	.0090	10.0275	.0105	10.0295	.0020	....	....	....
195	....	10.0080	....	10.0090	.0010	10.0190	.0100	10.0335	.0145	10.0335	.0000	....	....	....
200	10.0040	10.0090	.0050	10.0100	.0010	10.0200	.0100	10.0375	.0175	10.0385	.0010	....	....	....
205	....	10.0080	....	10.0110	.0030	10.0230	.0120	10.0415	.0185	10.0445	.0030	....	....	....
210	....	10.0100	....	10.0130	.0030	10.0255	.0125	10.0435	.0180	10.0485	.0050	....	....	....
215	....	10.0160	....	10.0220	.0060	10.0390	.0170	10.0555	.0165	10.0675	.0120	....	....	....
220	10.0160	10.0260	.0100	10.0320	.0060	10.0485	.0165	10.0795	.0310	10	(b)	....	....	....
222	10.0190	10.0280	.0090	10.0360	.0080	10.0570	.0210	10.1035	.0465	10	....	....	....	....
224	10.0220	10.0310	.0090	10.0400	.0090	10.0575	.0175	10.1385	.0810	10	....	....	....	....
226	10.0230	10.0340	.0110	10.0430	.0090	10.0605	.0175	10.1425	.0820	10	....	....	....	....
228	10.0260	10.0380	.0120	10.0470	.0090	10.0680	.0210	10.1445	.0765	10	....	....	....	....
230	10.0310	10.0420	.0110	10.0520	.0100	10.0750	.0230	10.1465	.0715	10	....	....	....	....
232	10.0330	10.0460	.0130	10.0590	.0130	10.0780	.0190	10.1605	.0825	10	....	....	....	....
234	10.0360	10.0500	.0140	10.0630	.0130	10.0845	.0215	10.1645	.0800	(b)	....	....	....	....
236	10.0390	10.0550	.0160	10.0690	.0140	10.0900	.0210	10.1625	.0725	....	....	....	....	....
238	10.0440	10.0600	.0160	10.0740	.0140	10.0960	.0220	10.1675	.0715	....	....	....	....	....
240	10.0450	10.0640	.0190	10.0790	.0150	10.1020	.0230	10.1745	.0725	....	....	....	....	....
242	10.0480	10.0690	.0210	10.0850	.0160	10.1110	.0260	10.1665	.0555	....	....	....	....	....
244	10.0530	10.0750	.0220	10.0920	.0170	10.1140	.0220	10.1685	.0545	....	....	....	....	....
246	10.0560	10.0800	.0240	10.0980	.0180	10.1370	.0390	10.1765	.0395	....	....	....	....	....
248	10.0590	10.0840	.0250	10.1040	.0200	10.1260	.0220	10.1835	.0575	....	....	....	....	....
250	10.0620	10.0910	.0290	10.1130	.0220	10.1320	.0190	10.1905	.0585	....	....	....	....	....

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[a] No contact after 180 inches.

[b] No contact after 215 inches.

The bore is very much eroded and scored. Beginning from about the middle of the length of the chamber, where the surface begins to be rough, the scoring gradually increases in depth to the beginning of rifling, where it is the deepest for about 1 caliber in length; along here the surface is very uneven and ragged, and the lands are almost indistinguishable from the grooves. The scoring is noticeably worse on the top half than on the bottom, and a little worse on the left than on the right.

At the left extremity of the horizontal diameter there is a wide and irregular furrow about 7 inches long and ¾ inch wide at the widest part. At the other extremity of the same diameter there is another furrow somewhat less noticeable. These two are the most pronounced, but there are also on top several narrower furrows that look like cracks from the breech, varying in length from 1 to 6 or 7 inches, and in some places from ¼ to ⅓ inch in width.

From the impressions these furrows seem to have a maximum depth of about ¼ inch below the general surface, but the deepest parts are smooth, as if there were no real cracks in the tube. From this point of the bore forward, the furrows become gradually less apparent for about 8 calibers, when the surface of the bore is again comparatively smooth. Owing to the unevenness of the scored part of the bore it is impossible to get good contact with the star gauge points, and the readings only give the approximate diameters

Star gauging of 10-inch B. L. rifle (steel), No. 1, type, Watervliet Arsenal, at Sandy Hook Proving Ground—Continued.

GROOVES.

[9.99845-inch ring and 10-inch points.]

Inches from muzzle.	After 217 rounds, Apr. 26, 1894.	After 292 rounds, Feb. 8, 1896.	Inches from muzzle.	After 217 rounds, Apr. 26, 1894.	After 292 rounds, Feb. 8, 1896.	Inches from muzzle.	After 217 rounds, Apr. 26, 1894.	After 292 rounds, Feb. 8, 1896.
	Inches.	*Inches.*		*Inches.*	*Inches.*		*Inches.*	*Inches.*
0	10.1170	10.1165	100	10.1250	10.1235	200	10.1465	....
5	10.1235	10.1205	105	10.1255	10.1235	205	10.1500	....
10	10.1245	10.1225	110	10.1255	10.1245	210	10.1535	....
15	10.1230	10.1205	115	10.1270	10.1265	215	10.1580	....
20	10.1220	10.1205	120	10.1265	10.1265	220	10.1605	....
25	10.1215	10.1205	125	10.1265	10.1255	222	10.1595	....
30	10.1220	10.1215	130	10.1285	10.1265	224	10.1645	....
35	10.1220	10.1205	135	10.1295	10.1275	226	10.1680	....
40	10.1205	10.1205	140	10.1310	10.1315	228	10.1680	....
45	10.1225	10.1205	145	10.1310	10.1345	230	10.1705	....
50	10.1215	10.1195	150	10.1320	10.1345	232	10.1710	....
55	10.1225	10.1215	155	10.1310	10.1355	234	10.1705	....
60	10.1255	10.1225	160	10.1360	10.1405	236	10.1785	....
65	10.1245	10.1225	165	10.1385	10.1435	238	10.1805	....
70	10.1240	10.1215	170	10.1365	10.1485	240	10.1805	....
75	10.1240	10.1235	175	10.1395	10.1465	242	10.1820	....
80	10.1245	10.1235	180	10.1415	10.1525	244	10.1890	....
85	10.1225	10.1215	185	10.1425	(*a*)	246	10.1915	....
90	10.1220	10.1205	190	10.1420	....	248	10.1910	....
95	10.1230	10.1225	195	10.1445	....	250	10.1905	....

a No contact after 180 inches.

Plate I.

6360·6 yards

55·68 "

4·72 "

55·887 "

159·0 "

16·0 "

576 lbs.

5°

Sept. 25th 1836.

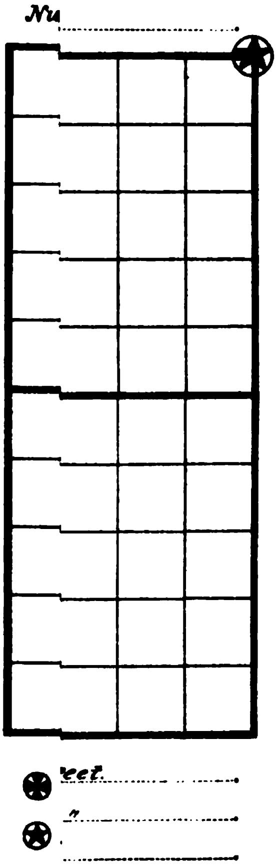
Appendix II, [illegible].

Ord 54 2

rsenal.

Ord 54 2

April 26th 1892.



N. J. May 2d 1892.

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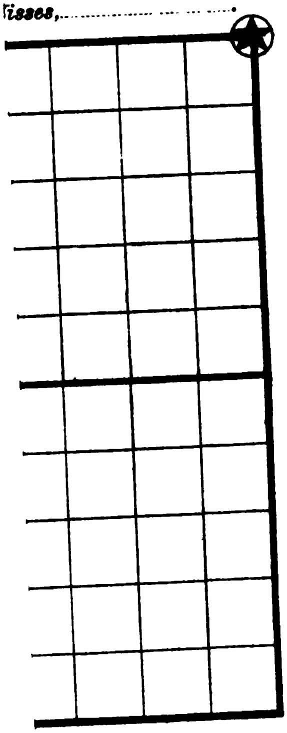
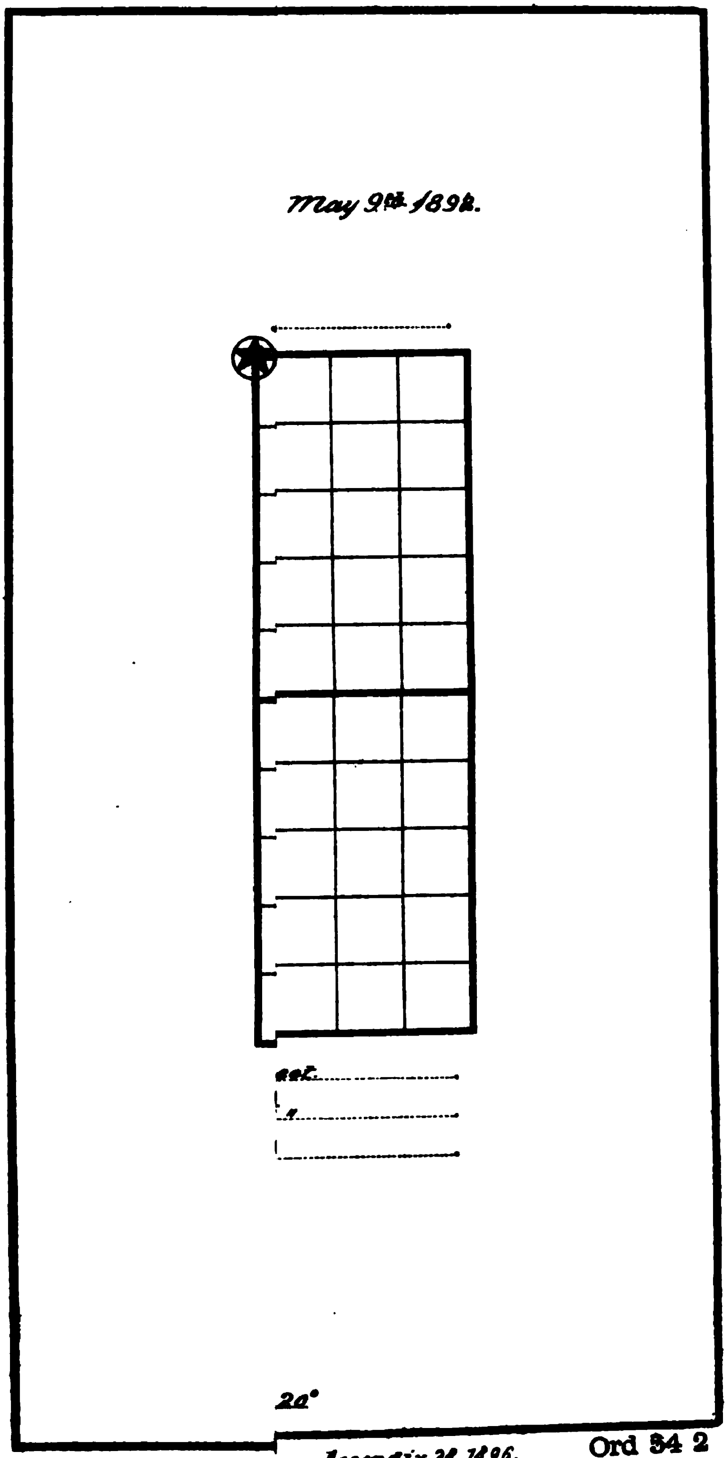


feet

5



May 9th 1892.

Appendix 28, 1896.

Ord 54 2

. J. Aug. 10th 1895.

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3 feet

54 "

HE BOARD FOR T

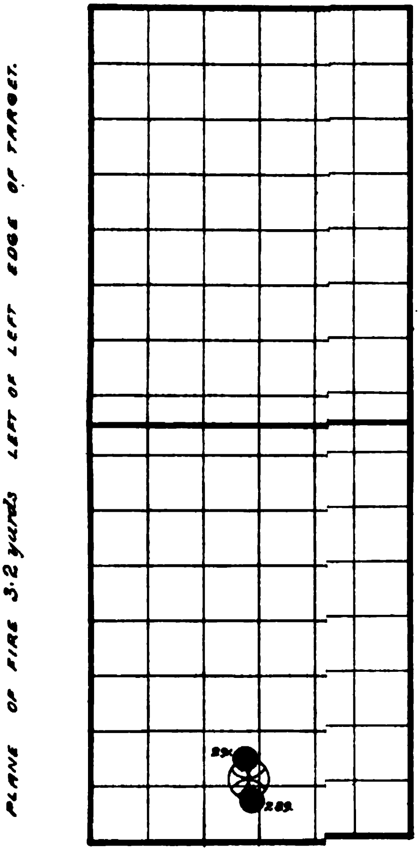
35°

Appendix 28, 1896.

Ord 54 2

TARGE

Number of shots fired 5



● *Center of impact.*

⊛ *Point aimed at.*

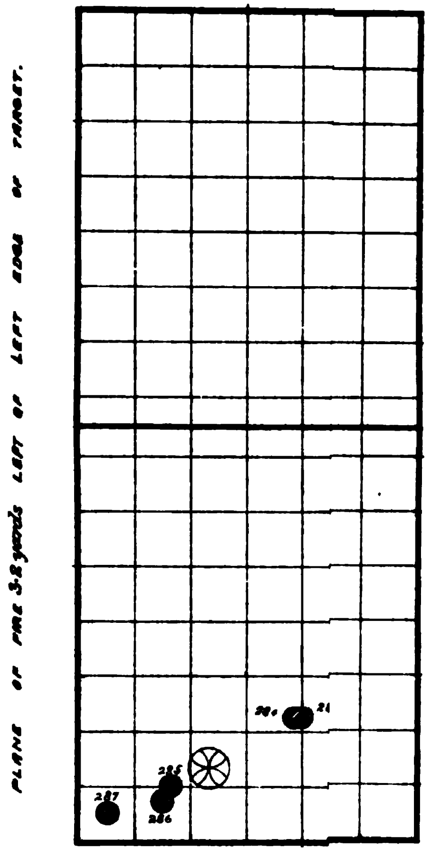
Ta

ix 28, 1896.

Ord 54 2

TARGE

Number of shots fired, 5



● *Center of impact.*

● *Point aimed at.*

Targ

ax 28, 1896.

Ord 54 2

APPENDIX 29.

TRIAL OF CROZIER 10-INCH WIRE-WOUND B. L. RIFLE.

SANDY HOOK PROVING GROUND,
February 12, 1896.

Report of Board for Testing Rifled Cannon, appointed under the act of Congress approved July 5, 1884.

The 10-inch Crozier wire-wound rifle was turned over to the Board at the Sandy Hook Proving Ground, Sandy Hook, N. J., for test in compliance with instructions of the Chief of Ordnance, U. S. A., dated January 20, 1896.

When received by the Board it had been fired, in all, 275 rounds, and was so eroded as to be no longer in suitable condition for firing. The Board, therefore, has had no opportunity of witnessing the test or personally observing the workings of the gun. From an examination of the gun and the results of firings made by the Ordnance Board which it had an opportunity of considering, the Board finds that the general programme adopted for the 10-inch B. L. rifle, steel, No. 1, was followed in this test and that the gun satisfactorily met all requirements as to rapidity, accuracy, and general efficiency. The following facts are taken from the records of firing of this piece, which, together with plots of targets, star-gauge records, and impressions of the bore, were forwarded to the Chief of Ordnance, U. S. A., with the report of the Ordnance Board under whose direction the firings were made. General attention to these papers is invited by the Board in connection with this report.

A description and drawings of this gun are on file in the Ordnance Department.

The gun was designed for a pressure of 42,000 pounds per square inch and a muzzle velocity of 2,100 feet per second, using from 260 pounds to 290 pounds of brown prismatic powder and a projectile weighing 575 pounds.

A total of 275 rounds have been fired, of which 20 gave pressures below 35,000 pounds per square inch, 14 between 35,000 and 40,000 pounds, 231 between 40,000 and 45,000 pounds, and 10 over 45,000 pounds. The maximum pressure was 46,000 pounds per square inch.

Targets were made as follows:

After 94 rounds, of ten shots at 3,000 yards with 3.04 feet mean deviation.
After 107 rounds, of ten shots at 1 mile with 1.8 feet mean deviation.
After 128 rounds, of ten shots at 1 mile with 4.64 feet mean deviation.
After 189 rounds, of eight shots at 1 mile with 1.89 feet mean deviation.
After 189 rounds, of eight shots at 1 mile with 2.29 feet mean deviation.
After 270 rounds, of five shots at 1 mile with 1.95 feet mean deviation.

The fourth and fifth targets were of alternate shots to insure identity of conditions in the test of two methods of sighting.

The gun is now so eroded at the commencement of the rifling that it is not considered judicious to subject it to further firing if a relining of the tube is contemplated.

Taking into consideration the fact that an unusually large proportion of the number of rounds fired gave pressures equal to or exceeding the designed pressure, the Board considers the endurance of this piece as entirely satisfactory.

The 10-inch Crozier wire-wound rifle has been subjected to the proper test for the determination of the endurance of the same, and the Board therefore considers that the 10-inch Crozier wire-wound rifle is a suitable gun to be put in the Government service.

The Board considers that it is highly desirable to test the effect of relining the tube, and to that end recommends that this gun be relined and subjected to such further test as may be deemed advisable.

ISAAC ARNOLD, Jr.,
Major, Ordnance Department, U. S. A., President.
FRANK H. PHIPPS,
Major, Ordnance Department, U. S. A.
J. W. REILLY,
Major, Ordnance Department, U. S. A.
FRANK HEATH,
Captain, Ordnance Department, U. S. A.
W. S. PEIRCE,
Lieutenant, Ordnance Department, U. S. A., Recorder.

(3710—Enc. 13)

APPENDIX 30.

TRIAL OF 12-INCH B. L. RIFLE, STEEL, TYPE.

(2 plates.)

SANDY HOOK PROVING GROUND,
October 11, 1896.

Report of test made by the Board for Testing Rifled Cannon, appointed under the act of Congress approved July 5, 1884.

The 12-inch B. L. rifle, steel, No. 1, was turned over to the Board at the Sandy Hook Proving Ground, Sandy Hook, N. J., for test in compliance with instructions of the Chief of Ordnance, U. S. A., dated April 20, 1892.

DESCRIPTION.

The description of this piece is omitted as it has already been fully described in the Report of the Chief of Ordnance, 1891, page 185.

Thirty-two rounds had been fired from this gun before it passed into the hands of the Board. Of this number nearly all were fired in the proof of different lots of powder manufactured for the test of this gun. The pressures obtained in these rounds ranged as follows:

Between 16,000 and 24,000 pounds per square inch.	Between 24,000 and 30,000 pounds per square inch.	Between 30,000 and 35,000 pounds per square inch.	Between 35,000 and 38,000 pounds per square inch.	Over 38,000 pounds per square inch.
4	9	8	4	5

No pressures were recorded for two rounds.

MOUNTS.

The mounts used in the test of this gun, together with the total number of rounds fired from each, are as follows:

	Rounds.
Imitation Krupp carriage	62
Schneider carriage on gun lift	121
12-inch barbette, service	38
12-inch proof carriage	6
Total	227

TEST.

The Board adopted the following programme for the test of this gun:

ENDURANCE.

The gun to be fired 250 rounds, using a charge of about 450 pounds of powder and a projectile weighing 1,000 pounds, giving a muzzle velocity of about 1,975 feet per second and a pressure of about 37,000 pounds per square inch. Pressures and velocities to be taken and the gun star-gauged and impressions made as often as the Board may deem necessary; this test to include the following tests for accuracy, range, and rapidity.

ACCURACY.

Fifteen rounds in groups of 5 each at the 3,000-yard target; 12 rounds in groups of 3 each to sea using elevation of 5°, 10°, 15°, and 20°.

RAPIDITY.

One or more groups of 10 rounds each, all facilities being used to overcome unnecessary delays in firing.

The programme of test was subsequently amended by the Board as follows:

That 20 rounds in groups of 5 each be fired to sea, using elevations of 5°, 10°, 15°, and 20°, or the maximum elevation attainable on the carriage on which the gun may be mounted. All the remaining rounds to be fired with charges of about 500 pounds, giving pressures not to exceed 38,000 pounds per square inch.

POWDER.

The requirements of the powder for the 12-inch B. L. rifle, steel, type, are as follows:

Kind of powder, brown prismatic.

Charge	pounds	450
Pressure	pounds per square inch	37,000
Initial velocity	feet per second	1,975

From the firing record it will be seen that powder fulfilling these requirements was not obtained in any quantity until the test of the gun had been more than half completed.

The table given below shows the different powders used in this gun and the number of rounds fired with each:

	Rounds.
German brown prismatic:	
For 10-inch rifle	2
For 12-inch rifle	7
Du Pont's brown prismatic:	
V. P	4
V. P., lot 2	4
V. P., lot 3	4
V. P., lot 4	6
V. P., lot 5	5
V. P., lot 6	4
V. P., lot 7	4
V. P., lot 8	4
V. P., lot 9	4
V. P., lot 10	5
French smokeless, B. N	8
Du Pont's brown prismatic:	
V. P., lot 11	3
Mixture of 9 and 11	1
V. P., lot 13	3
V. Y., lot 3	2
Du Pont's brown prismatic—Con.	
V. P., lot 12	2
V. P., lot 14	4
V. P., lot 15	8
V. P., lot 16	3
V. P., lot 17	1
V. P., lot 18	3
V. U., lot 16	1
V. P., lot 24	4
W. R	2
W. Q	9
W. U., lot 2	4
W. Z	3
W. Z., lot 2	25
W. Z., lot 4	12
W. Z., lot 5	31
W. Z., lot 6	45
Total	227

PROJECTILES.

The projectiles used were cast-iron shot. The following table shows the number of rounds fired with the different lots and weights used:

	Weight.	Rounds.
	Pounds.	
Cored shot	850	1
Solid shot:		
Lot 317	1,000	50
Lot 333	1,000	38
Lot 344	1,000	20
Rebanded	1,000	5
Lot 373	1,000	45
Lot 337	1,000	3
Lot 650	1,000	21
Lot 690	1,000	8
Lot 709	1,004	36
Total		227

The increased weight of the shot of lot 709 was due to the use of larger bands, which the condition of the bore of the gun rendered necessary toward the last.

ENDURANCE.

THE GUN.

The 12-inch B. L. rifle, steel, No. 1, has been fired 227 rounds. Of this number 135 have given pressures above 35,000 pounds per square inch. The maximum pressure recorded was 73,800 pounds per square inch. As a result of this test the only injury discoverable is that due to the erosion of the powder gases. In all other respects the gun is apparently able to endure an indefinite number of additional rounds. The erosion, however, has now proceeded so far as to affect the accuracy of fire. For this reason, and also to permit the relining of the tube, should that be desired, the Board suspended further test of this gun.

The effect of this erosive action upon the accuracy was not material until after the one hundred and eighty-fifth round. At this point it was noticed, as in the case of the 10-inch B. L. rifle, steel, that the travel of the projectile had decreased and that the service band did not take the rifling well. At the one hundred and ninetieth round the diameter of the band was increased 0.1 inch, with marked effect upon the accuracy of fire. It is quite evident that the use of these larger bands prolonged the life of the gun by some 40 rounds. With the same charge the muzzle velocity was increased about 30 feet per second, and the pressure, which had fallen below 35,000 pounds, was brought up to 38,000 pounds per square inch.

A slight forward movement of the chase hoops occurred during the early part of the test. The muzzle hoop projected about 0.05 inch in front of the tube at the muzzle. Further firing did not sensibly increase this distance, the hoops apparently having readjusted themselves in a more stable position.

BREECH MECHANISM.

The gas-check cups with which this gun was originally fitted caused great trouble at first. They were continually sticking and rendering very difficult the work of opening the breech after firing. At the eighty-third round one steel split ring, placed next the rear cup, was tried, and at the next round a second ring at the front cup was added. No further trouble was experienced from this source.

The pinions of the rotating gearing as originally made proved too weak. At the fifteenth round a tooth of the crank-shaft pinion broke, became wedged and prevented rotation of the block. To open the breech the translating stud on the block had to be cut off and the breechplate removed. A new tooth was put in the pinion, and a new translating stud fitted to the block. At the nineteenth round, however, the new tooth broke in the same manner. The pressures recorded for these two rounds were 33,820 pounds per square inch for the first, and less than 28,000 pounds per square inch for the second. After the nineteenth round a new pinion and crank shaft were put in, but at the twenty-seventh round one tooth in the new pinion and two in the middle pinion broke. The pressure was 46,100 pounds per square inch.

The broken pinions were replaced by double-shrouded ones. These appeared to be strong enough and gave no trouble, even with the very high pressures, subsequently attained. After the two hundred and twenty-fifth round a tooth in the pinion of the compound gear was found broken. The appearance of the fracture indicated that the tooth had been cracked for some time.

Some trouble was also experienced at first with the tray latch spring bolt. The small diameter of the bolt permitted it to rise and jam in the threads of the translating roller when the block was being run in. After the eighty-third round the bolt was increased in diameter and since that time has given less trouble.

In service guns this bolt is provided with a broad shoe of steel on its upper end which renders such jamming impossible.

The translating stud and roller on this gun can not be considered satisfactory. The stud has bearing in the threads of the roller practically only along one element. This resulted in continual burring of the stud and the indenting of the threads of the roller at the points corresponding to the open and closed positions of the stud.

The 12-inch, No. 16, with which the rapidity test was made had several new features in its new breech mechanism. The bearing surfaces of the translating stud were much increased by giving them an helicoidal form, and the groove in the translating roller was cut with uniform pitch throughout. A device for locking the block to the tray when the block is withdrawn had also been added. These alterations were considered distinct improvements by the Board, and their general adoption is recommended.

The test of this gun, as well as of similar guns of smaller caliber, has developed the fact that when new pads are used there is a distinct tendency of the system to loosen sufficiently to prevent the proper simultaneous action of the parts. This is caused by the compression of the pads under the powder pressure to which it is subjected, which pressure is five or six times as great as the pressure which can be given the pad in manufacture. When the system becomes loosened, as above described, it should be restored to its normal condition by screwing home the obturator nut without undue force, but sufficiently to hold the parts closely together. After the pad has received its permanent compression, it is believed that the spindle system is sufficiently elastic to admit of its being forced to the rear under the powder pressure, thus affording an opportunity for the action, under shock of discharge, of any tendency on the part of the obturator nut to screw up and lock the split rings and pad in their expanded condition, and so prevent free movement of the breechblock. It is also possible that this setback of the system may be sufficient to permit the spring washer on the spindle to become displaced, as described later on in this report, and thus, independently of any movement of the obturator nut, to produce such an expansion of the gas check as to render rotation of the block very difficult. It is believed that this subject calls for careful and thorough investigation with a view to the adoption of the modifications necessary to correct the imperfections noted.

With the changes above mentioned, viz, the new translating stud, block-locking device, and modification of the spindle system, the breech mechanism will be serviceable; but the Board considers that this mechanism is not as well adapted to 12-inch guns as it is to the smaller calibers, and it is therefore recommended that steps be taken as soon as practicable with a view to the selection of a system better adapted to guns of 12-inch caliber.

ACCURACY.

Several targets have been made at different ranges. A plat of each target with required data accompanies this report.

The accuracy of this gun is considered satisfactory.

RAPIDITY.

On account of unavoidable delays in getting this gun upon a mount from which the rapidity trial could properly be made, the test had proceeded to the point where further firing was thought unadvisable before this part of the programme was reached. Authority was therefore obtained from the Chief of Ordnance, under date of July 29, 1896, to make the rapidity test with 12-inch B. L. rifle No. 16, a gun of the same model as the type gun. On cleaning the bore of this gun for the trial, what appeared to be a crack was noticed near the origin of the rifling. An impression of the bore taken at this point showed a fine line running diagonally across the grooves and lands extending circumferentially about 3 inches. It was impossible to decide certainly whether this was actually a crack or merely the result of erosion. The Board therefore decided, before proceeding with the rapidity test, to fire five rounds with service pressures, examining the bore after each round. This was done. An impression of the bore was also taken after the third round. On this impression the outline of the suspected crack was shorter and less well defined, and the Board accordingly concluded that it was merely the result of erosion.

A rapidity test of five rounds was then fired, the gun being mounted upon the 12-inch barbette carriage, type. The time for the five rounds was 25 minutes 20 seconds. After the third round the block was rotated with great difficulty. The spindle nuts were found to have tightened, expanding the split rings and pad. Four minutes and 16 seconds were consumed in loosening these nuts. After the fourth round trouble was again experienced in rotating the block, causing a further delay of 1 minute 26 seconds. On closing the breech for the fifth round the block was translated and rotated with the utmost difficulty. The result of this trial was considered unsatisfactory. At its close the breech mechanism was taken apart for inspection. It was found that the spring washer on the spindle had in some way become displaced and by dropping down between the obturator nut and the rear friction washer had thus wedged the spindle back, expanding the gas check and causing it to bind in its seat. The spring washer was much cut and deformed.

The undersigned members of the Board while agreeing with most of the opinions and conclusions of the remaining members, as above expressed, must dissent from that part relating to the compression of the pad, the elasticity of the spindle system, and the action of the obturator and locking nuts under firing.

It is fully recognized that the proof charges will considerably compress a new pad but, in subsequent firing, unless pressures considerably in excess of the proof are experienced it is not believed that any such additional compression can occur as would be required to afford the obturator nut opportunity for tightening or necessary to so alter the adjustment of the system as to permit the falling of the spring washer.

In some of the recent firings the spring washer certainly did fall and the nuts did tighten, but the cause is believed to be a failure to properly adjust the spindle system after the proof firing, or to be due to an intentional loosening of the nuts, thinking (which is an erroneous idea) that such action would facilitate the rotation of the breechblock after discharge.

If the system is properly adjusted, after the pad has taken its final set, it is believed it will so remain, with possibly only immaterial alterations, during subsequent firing. The second rapidity test, especially undertaken to elucidate this point, showed no dropping of the spring washer, no movement of the nuts, no tightening or loosening of the system, and no sticking of the block at the initial rotation, facts certainly entitled to as much weight as the contrary first observed. In the latter case, however, it is certain the system was properly assembled; in the former the results then experienced and the statements then made as to the manner of setting the nuts, make it somewhat doubtful whether these results were not occasioned more by the peculiar adjustments given, than by any features inherent to a proper use of the system itself.

It is believed that this point is still open and can only be conclusively determined by additional firing.

Isaac Arnold, Jr.,
Major, Ordnance Department, U. S A., President.
J. W. Reilly,
Major, Ordnance Department, U. S. A.

(11381—Enc. 19)

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons), Watervliet

[Object of firing.

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Powder. Number of prisms.	Projectile. Kind.	Projectile. Weight.	Travel of shot in bore.	Elevation.
1891. P. M.			*Pounds.*			*Pounds.*	*Inches.*	° '
July 24	1	German brown prismatic, for 10-inch B. L. rifle, 79 prisms in cross section.	Front cartridge.. 125 Rear cartridge... 125 250	Brown.. 1,255 Brown.. 1,248 Black... 7	Solid shot, lot 317.	997	330.75	0 15
July 24	2		Front cartridge.. 150 Rear cartridge... 150 300	Brown.. 1,504 Brown.. 1,499 Black... 7		1,000	330.75	0 15
July 24	3	German brown prismatic for 12-inch B. L. rifle, 79 prisms in cross section.	Front cartridge.. 117 Center cartridge. 117 Rear cartridge... 116 350	Brown.. 1,178 Brown.. 1,181 Brown.. 1,166 Black... 7		1,000	330.75	0 15
July 24	4		Front cartridge.. 125 Center cartridge. 125 Rear cartridge... 125 375	Brown.. 1,263 Brown.. 1,263 Brown.. 1,255 Black... 7		1,000	330.1	0 15
July 25	5		Front cartridge.. 133 Center cartridge. 133 Rear cartridge... 104 370	Brown.. 1,344 Brown.. 1,343 Brown.. 1,045 Black... 7	Cored shot, single band, lot 198.	812 Sand, 38 850	331.25	0 15

[Object of firing.

1891. Aug. 11	6	Du Pont's brown prismatic, V. P.; density, 1.830; 79 prisms in cross section; sample received Aug. 5, 1891.	Front cartridge.. 150 Rear cartridge... 150 300	Brown.. 1,645 Brown.. 1,638 Black... 7	Solid shot, lot 317.	1,000	330.80	0
Aug. 11	7		Front cartridge.. 115 Center cartridge. 115 Rear cartridge... 120 350	Brown.. 1,262 Brown.. 1,262 Brown.. 1,319 Black... 7		1,000	331.20	0

Arsenal, at Sandy Hook Proving Ground, from July 24, 1891, to November 22, 1892.

to test gun.]

Instrumental velocity, 275 feet from muzzle.	Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Feet.	*Pounds.*	*Ft.*	*In.*	*Ft.*	*In.*			
1,476 1,473	F, 19,920 H, 20,000	5	8½	5	8½	Wind from right, 7 miles an hour.	Mallet used to rotate breechblock in opening. Locking bolt broken by mallet in rotating breechblock. Bolt removed. Threads in upper sector left side of breech found slightly scored; scores removed with emery cloth. Copper cylinders of 18,000 pounds initial compression and tables of 1890.	Gun mounted on Krupp imitation carriage, altered. Cylinders fitted with steel obturating bars. 22 gallons of oil in each cylinder. Obturating electric primers, April 11, 1890. Cartridge bag cut. Fired to sea. Chamber sponged out after each round to facilitate loading of projectile. All nuts on holding-down bolts in pintle plate tightened after each round. After round 1 handle of rotating crank lashed to console with wire. Except in round 1 breech mechanism was easily operated by 1 man. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
1,610 1,609	F, 27,400 D, 27,683	5	8½	5	8½		Copper cylinders of 24,000 pounds initial compression and tables of 1887.	
1,776 1,762	D, 34,963 F, 32,600	6	5½	6	5½		Copper cylinder of 24,000 pounds initial compression used in gauge D, tables of 1887. Copper cylinder of 28,000 pounds initial compression used in gauge F, tables of 1890.	
1,869 1,855	F, 38,692 D, 39,177	6	7¾	6	7¾		Holding-down bolt in front on left of pintle plate broken in the threads. Copper cylinders of 32,000 pounds initial compression and tables of 1890.	
1,960 1,943 200+½°	D, 38,091 F, 39,044	6	2½	6	2½	Wind from right and front, 3 miles an hour.	Copper cylinders of 32,000 pounds initial compression and tables of 1890.	

to prove powder.]

1,476 1,469	D, less than 24,000 F, less than 24,000	5	10½	5	10½	Wind from right and front, 30°, 4 miles an hour.	Mallet used to rotate breechblock in opening. Copper cylinders of 24,000 pounds initial compression and tables of 1887.	Gun mounted on Krupp imitation carriage, altered. Cylinders fitted with steel obturating bars. 2 gallons of oil added to right cylinder, 1 gallon to left cylinder. Since last firing holding-down bolt in pintleplate (broken in previous firing) and 2 others not broken drilled out and new bolts put in. New locking
1,533 1,528	D, less than 24,000 F, less than 24,000	6	1	6	1		In opening in rotating breechblock last turn made with slight difficulty by 3 men. Copper cylinders of 24,000 pounds initial compression and tables of 1887.	

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing,

Date.	No. of fire.	Powder.			Projectile.		Travel of shot in bore.	Elevation.	
		Kind.	Weight.	Number of prisms.	Kind.	Weight.			
1891. P. M.			*Pounds.*			*Pounds.*	*Inches.*	°	'
Aug. 11	8	Du Pont's brown prismatic, V. P.; density, 1.830; 79 prisms in cross section; sample received Aug. 5, 1891.	Front cartridge.. 135 Center cartridge. 130 Rear cartridge... 135 400	Brown.. 1,479 Brown.. 1,425 Brown.. 1,473 Black... 7	Solid shot, lot 317.	1,000	330.80	0	0
Aug. 11	9		Front cartridge.. 145 Center cartridge. 145 Rear cartridge... 150 440	Brown.. 1,590 Brown.. 1,590 Brown.. 1,639 Black... 7		1,000	330.80	0	0

[Object of firing, to ascertain

1891. P. M. Aug. 24	10	German brown prismatic for 12-inch rifle, 79 prisms in cross section.	Front cartridge.. 175 Rear cartridge... 175 350	Brown.. 1,769 Brown.. 1,762 Black... 7	Solid shot, lot 317.	1,000	330.1	4	0
Aug. 24	11		Front cartridge.. 175 Rear cartridge... 175 350	Brown.. 1,769 Brown.. 1,758 Black... 7		1,000	330.1	6	0

Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

to prove powder.]

Instrumental velocity, 275 feet from muzzle.	Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Feet.	*Pounds.*	*Ft.*	*In.*	*Ft.*	*In.*			
1,687 1,692	D, 28,700 F, 28,915	6	3	6	3	Wind from right and front, 30°, 4 miles an hour.	In opening in rotating breechblock last turn made with slight difficulty by 3 men. Copper cylinders of 18,000 pounds initial compression and tables of 1890 used in gauge D. Copper cylinders of 24,000 pounds initial compression and tables of 1887 used in gauge F.	bolt in rotating crank. Fired to sea. Chamber sponged out after each round to facilitate loading of projectile. Front cup wiped off; obturator seat wiped out with moist waste and oiled after each round. Mushroom head, chamber, and entire bore covered with a yellow residue after each fire. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
1,797 1,786 $200+\frac{15}{2}$°	D, 34,380 F, 34,445	6	4	6	4		In opening in rotating breechblock last turn made with slight difficulty by 3 men. Copper cylinders of 28,000 pounds initial compression and tables of 1890.	

smoothness of flight of projectile.]

Instrumental velocity, 275 feet from muzzle.	Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
		Ft.	*In.*	*Ft.*	*In.*			
....	D, 32,640 F, 32,815	6	1	6	1	Wind from right, 90°, 8 miles an hour.	Latch failed to hold console in closing breechblock. First primer discharged but failed to ignite charge. In opening in rotating breechblock second quarter of revolution made with slight difficulty; after, perfectly easy by 1 man.	Gun mounted on Krupp imitation carriage, altered. Cylinders fitted with steel obturating bars. 2 gallons of oil put in cylinders. Obturating electric primers, Apr. 11, 1891. Fired to sea. Before this firing the breechblock was removed and threads smoothed down with fine emery. Translating stud found burred and slightly bent; burrs removed and stud straightened. Translating screw smoothed down with file and emery. Cartridge bag cut. Chamber sponged out and breech mechanism well oiled before each round. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
....	D, 32,000 F 36,080	6	2	6	2		In opening breechblock same difficulty as in previous round.	

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing

Date.	No. of fire.	Powder.			Projectile.		Travel of shot in bore.	Depression.
		Kind.	Weight.	Number of prisms.	Kind	Weight.		
1891.			*Pounds.*			*Pounds.*	*Inches.*	′
P. M.								
Aug. 26	12	Du Pont's brown prismatic, V. P., lot 2; density, 1.830; received Aug. 24, 1891; 79 prisms in cross section.	Front cartridge.. 150	Brown.. 1,638	Solid shot, lot 317.	1,000	330.65	35
			Rear cartridge... 150	Brown.. 1,631				
				Black... 7				
			300					
Aug. 26	13		Front cartridge.. 115	Brown.. 1,256		1,000	330.90	25
			Center cartridge. 115	Brown.. 1,257				
			Rear cartridge... 120	Brown.. 1,304				
				Black... 7				
			350					
Aug. 26	14		Front cartridge.. 130	Brown.. 1,421		1,000	330.75	23
			Center cartridge. 135	Brown.. 1,476				
			Rear cartridge... 135	Brown.. 1,469				
				Black... 7				
			400					
Aug. 26	15		Front cartridge.. 140	Brown.. 1,529		1,000	330.70	0
			Center cartridge. 150	Brown.. 1,639				
			Rear cartridge... 150	Brown.. 1,632				
				Black... 7				
			440					
Sept. 29	16	Du Pont's brown prismatic, V. P., lot 3; density, 1.840; 79 prisms in cross section; received Sept. 26, 1891.	Front cartridge.. 115	Brown. 1,254	Solid shot, lot 317.	997	330.80	25
			Center cartridge. 115	Brown.. 1,254				
			Rear cartridge... 120	Brown.. 1,301				
				Black... 7				
			350					
Sept. 29	17		Front cartridge.. 130	Brown.. 1,419		1,000	330.80	25
			Center cartridge. 135	Brown.. 1,473				
			Rear cartridge... 135	Brown.. 1,466				
				Black... 7				
			400					
Sept. 29	18		Front cartridge.. 140	Brown.. 1,526		1,000	330.80	30
			Center cartridge. 150	Brown.. 1,636				
			Rear cartridge... 150	Brown.. 1,629				
				Black... 7				
			440					

Waterrliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

to prove powder.]

Instrumental velocity, 275 feet from muzzle.	Pressure per square inch of bore.	Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech, mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Feet.	*Pounds.*	*Ft. In.*	*Ft. In.*			Gun mounted on Krupp imitation carriage, altered. Cylinders fitted with steel obturating bars. ½ gallon of oil put in cylinders. Obturating electric primers, Apr. 11, 1890. Cartridge bag cut. Chamber sponged out after each round to facilitate loading of projectile. Fired into sand butt, section 5, rounds 12 and 13; into section 3, round 14. Round 15 fired to sea. Before this firing hand wheel of elevating gear on right side of carriage repaired. Nuts on holding-down bolts in pintle plate tightened after each round. A thick yellow deposit found in chamber after each round. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
1,471 1,476	A, 18,250 B, 19,970	5 11	5 11	Wind from right and rear, 60°, 14 miles an hour.	Breech mechanism worked with perfect ease by 1 man.	
1,618 1,636	A, 24,200 B, 24,660	6 3	6 3		Breech mechanism worked with perfect ease by 1 man.	
1,736 1,745	A, Lost. B, 30,360	6 4	6 4		Breech mechanism worked with perfect ease by 1 man. First primer failed.	
1,835 1,865 200+$1\frac{1}{2}$°	A, 31,580 B, 38,820	6 6	6 6		Sixth tooth from top of pinion on crank shaft broken off. Fragments dropped down into gearing. Rotating gear jammed. To withdraw breechblock it was necessary to cut off projecting portion of translating stud and to remove the face plate of breech.	
1,666 1,670	B, 24,066 D, 25,450	6 2	6 2	Wind from right and front, 5°, 7 miles an hour.	In opening in rotating breechblock first turn made with slight difficulty. Copper cylinders of 18,000 pounds initial compression and tables of 1890 used in gauge B; copper cylinders of 24,000 pounds initial compression and tables of 1890 used in gauge D.	Gun mounted on Krupp imitation carriage, altered. Cylinders fitted with steel obturating bars. Before this firing broken tooth in pinion of rotating gear replaced. Translating stud replaced by one of new design (Watervliet Arsenal, Sept. 1, 1891). Fired into sand butt, section 5. Chamber sponged out after each round and mechanism well oiled. Latch of console loses hold when block is nearly in. Copper cylinders of 28,000 pounds initial compression and tables of 1890 used in rounds 17 and 18. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer
1,762 1,766	B, 28,142 D, 29,600	6 3	6 3		In opening breechblock same difficulty in rotating as in previous round.	
1,879 1,883 200+$1\frac{5}{8}$°	B, 34,300 D, Lost.	6 6	6 6		In opening breechblock same difficulty in rotating as in previous rounds, mallet being used in this round.	

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing, exhibition before the

Date.	No. of fire.	Powder.			Projectile.		Travel of shot in bore.	Elevation.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.		
1891. A. M.			*Pounds.*			*Pounds.*	*Inches.*	° ′
Oct. 10	19	German brown prismatic for 12-inch rifle; 79 prisms in cross section.	Front cartridge.. 115 Center cartridge. 115 Rear cartridge... 120 350	Brown.. 1, 136 Brown.. 1, 161 Brown.. 1, 207 Black... 7	Solid shot, lot 317.	1,000	330. 60	6 0

[Object of firing.

1891. P. M. Oct. 12	....	Du Pont's hexagonal, E. V. M.; density, 1.750; granulation, 100.	125	....	....	....	....	....
Oct. 12	20	Du Pont's brown prismatic, V. P., lot 3; density, 1.840; 79 prisms in cross section.	Front cartridge.. 150 Center cartridge. 160 Rear cartridge... 150 460	Brown.. 1, 696 Brown.. 1, 745 Brown.. 1, 629 Black... 7	Solid shot, lot 317.	1,000	330. 60	0 0

[Object of firing, to verify

1891. Oct. 14	21	German brown prismatic for 12-inch rifle; 79 prisms in cross section.	Front cartridge.. 115 Center cartridge. 115 Rear cartridge... 120 350	Brown.. 1, 161 Brown.. 1, 161 Brown.. 1, 206 Black... 7	Solid shot, lot 317.	1,000	330. 80	0 35

Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

Secretary of War and Chief of Ordnance.]

Instrumental velocity, 275 feet from muzzle.	Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Feet.	*Pounds.*	*Ft.*	*In.*	*Ft.*	*In.*			
....	B, less than 28,000 D, less than 28,000	6	6	6	6	Wind, 10 miles an hour.	Handle of translating roller removed before firing. First primer failed. Console flew open and closed again in recoiling. 1 tooth of pinion of rotating gear broken. The tooth was the one inserted in the place of the one broken in round 15. Rotating gear jammed. Block withdrawn by removing face plate.	Gun mounted on Krupp imitation carriage. Obturating electric primers.

to test powder.]

....	....	....		....		Wind from left and rear, 10°, 20 miles an hour.	Warming charge. No projectile. 3 obturating friction and 2 obturating electric primers failed.	Before this firing new upper pinion and crank handle and shaft put in rotating gear of breech mechanism. Teeth of middle pinion filed, and threads of breechblock smoothed off.
Lost. 1,990 200+$\frac{15}{8}$°	B, less than 28,000 D, less than 28,000	7	7	7	7		Carriage 3 inches out of battery when gun was fired. In opening in rotating breechblock last 2 turns made with great difficulty, mallet being used. Pintle pin raised 2 inches from pintle. Rear stuffing box of left cylinder blown out. Packing blown to the rear and oil expelled from cylinder.	Fired to sea. Cartridge bag cut. Copper cylinders of 28,000 pounds initial compression and tables of 1890. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.

pressures of previous round.]

1,755 1,754 200+$\frac{15}{2}$°	C, 30,620 D, 29,846	6	6	6	6	Wind from right and rear, 20°, 6 miles an hour.	In closing in rotating breechblock last 2 turns made with slight difficulty. After firing, breechblock found rotated over a very small arc. In opening, first half turn of rotation made by use of mallet, the rest being easy. Hand and clamp wheels of elevating gear loosened by shock. Copper cylinders of 28,000 pounds initial compression and tables of 1890 used in gauge C. Copper cylinders of 24,000 pounds initial compression and tables of 1890 used in gauge D.	Gun mounted on Krupp imitation carriage. Obturating friction primers. Cartridge bag cut. Before this firing cylinder filled with oil and left stuffing box replaced. Packing in left stuffing box reduced in thickness by 2½ inches. Fired to sea. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer. Gun star gauged Nov. 12, 1891, by Lieut. O. M. Lissak, Ordnance Department.

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing

Date.	No. of fire.	Powder.			Projectile.		Travel of shot in bore.	Elevation.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.		
1891.			*Pounds.*			*Pounds.*	*Inches.*	
Nov. 13	22	Du Pont's brown prismatic, V. P., lot 4; density, 1.835; received Nov. 12, 1891; 79 prisms in cross secton.	Front cartridge.. 115 Center cartridge. 115 Rear cartridge... 120 350	Brown.. 1,253 Brown.. 1,254 Brown.. 1,301 Black... 7	Solid shot, lot 317.	989	330.7	0
Nov. 13	23		Front cartridge.. 130 Center cartridge. 135 Rear cartridge... 135 400	Brown.. 1,416 Brown.. 1,469 Brown.. 1,463 Black... 7		993	330.9	0
P. M. Dec. 23	24	Du Pont's brown prismatic, V. P., lot 4; density, 1.835; received Nov. 12, 1891.	172	Brown.. 1,864 Black... 7		999	330.60	15
Dec. 23	25		Front cartridge.. 140 Center cartridge. 150 Rear cartridge... 150 440	Brown.. 1,225 Brown.. 1,632 Brown.. 1,625 Black... 7		1,000	330.50	25

Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

to prove powder.]

Instrumental velocity, 275 feet from muzzle.	Pressure per square inch of bore.	Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Feet. 1,708 1,709	*Pounds.* J, 24,800 K, 25,877	*Ft. In.* 6 1	*Ft. In.* 6 1	Wind from left and rear, 20°, 7 miles an hour.	Breechblock closed with difficulty. Tray latch failed to hold console when block was being forced home. In opening in rotating breechblock first turn made with difficulty. Copper cylinders of 18,000 pounds initial compression and tables of 1890. Escape of gas into gauge K through 2 holes in anvil—pressure unreliable. Copper washer cut through and channel cut in shoulder of gauge, first thread badly fused and bent and second thread slightly bent. Diameter of threads about $\frac{1}{32}$ inch smaller than corresponding diameter of recess for gauge. Piston had to be driven out with hammer after firing.	Gun mounted on Krupp imitation carriage. Before firing all bolts in carriage tightened. Upper and middle pinions of rotating gear replaced by 2 shrouded pinions. Cylinders filled with oil before firing. Fired to sea. Residue in bore after discharge formed a thick scale. Maximum thickness more than ⅛ inch. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.
1,810 1,811 200+1⅝°	H, 29,800 J, 27,200	......	......		On account of residue in bore battering ram was used to force shot home. Tongue from carriage to pintle plate broke across ring at front end. Carriage driven back 11 feet. Three traverse circles torn away and bolts sheared by front traverse wheels. Rear step on right side, with its support, bent and broken. Slight flaw evident in right fracture of tongue. Both fractures crystalline. Copper cylinders of 24,000 pounds initial compression and tables of 1890. Escape of gas into J gauge through 2 holes in anvil—pressure unreliable. Copper washer cut through and fusion at 2 places just forward of first thread, which is badly worn and bent. Diameter of threads about $\frac{1}{32}$ inch less than corresponding diameter of recess in head. Piston has always worked hard.	
......	......	......	......	Wind from rear and right, 77°, 16 miles an hour.	Warming charge; fired into butt. Shot struck in front of butt and ricochetted over. Indicator failed to register recoil.	Obturating electric primers. 3 gallons of oil added to cylinders before firing. Fired to sea. Repairs to carriage; broken tongue of carriage replaced by new one. Traverse circle replaced. Step repaired. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.
1,950 1,945 200+1⅝°	A, 35,835 J, less than 32,000	6 8	6 8		Thick powder scale in bore, necessitating use of battering ram to force shot home. Gland of left stuffing box blown off. Copper cylinders of 32,000 pounds initial compression and tables of 1890.	

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing.

Date.	No. of fire.	Powder.			Projectile.		Travel of shot in bore.	Depression.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.		
			Pounds.			*Pounds.*	*Inches.*	′
1891. P. M. Dec. 29	26	Du Pont's brown prismatic, V. P., lot 3; density, 1.840.	168	1,825	Solid shot, lot 317.	1,000	....	10
Dec. 29	27	Du Pont's brown prismatic, V. P., lot 4; density, 1.835; received Nov. 12, 1891; 79 prisms in cross section.	Front cartridge.. 150 Center cartridge. 150 Rear cartridge... 150 450	Brown.. 1,633 Brown.. 1,633 Brown.. 1,625 Black... 7		1,000	330.4	25
1892. A. M. Mar. 19	28	Du Pont's brown prismatic, V. P., lot 5; density, 1.835; received Jan. 28, 1892; 79 prisms in cross section.	Front cartridge.. 130 Center cartridge. 130 Rear cartridge... 140 400	Brown.. 1,425 Brown.. 1,425 Brown.. 1,520 Black... 7		999	330.70	0
Mar. 19	29		Front cartridge.. 140 Center cartridge. 150 Rear cartridge... 150 440	Brown.. 1,525 Brown.. 1,640 Brown.. 1,639 Black... 7		1,000	330.80	0
Mar. 19	30		Front cartridge.. 150 Center cartridge. 150 Rear cartridge... 150 450	Brown.. 1,647 Brown.. 1,647 Brown.. 1,639 Black... 7		1,000	330.80	0
Mar. 19	31		Front cartridge.. 150 Center cartridge. 150 Rear cartridge... 150 450	Brown.. 1,646 Brown.. 1,646 Brown.. 1,661 Black... 7		999	330.80	0
Mar. 19	32		Front cartridge.. 150 Center cartridge. 150 Rear cartridge... 150 450	Brown.. 1,645 Brown.. 1,646 Brown.. 1,639 Black... 7		1,000	330.80	0

***Watervliet Arsenal, at Sandy Hook Proving Ground, etc.*—Continued.**

to prove powder.]

Instrumental velocity, 275 feet from muzzle.	Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Feet.	*Pounds.*	*Ft.*	*In.*	*Ft.*	*In.*			
....	....	4	1	4	1	Wind from rear, 12 miles an hour.	Warming charge fired into butt. Shot struck a short distance in front of butt.	Gun mounted on imitation Krupp carriage. Cylinders filled with oil before firing. Obturating electric primers. Chamber sponged out and bore scraped after each round. Fired to sea. ½-inch bolts in rear stuffing boxes of hydraulic cylinders replaced by ⅝-inch bolts before this firing. Slight leakage of oil through rear stuffing box of left cylinder. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.
1,962 1,956 200+1⅝°	A, 46,100 J, 40,950	6	7	6	7		One tooth of upper rotating gear and 2 in middle pinion broken. 1 pound 7 ounces of residue removed from gun between shot seat and breech. Copper cylinders of 32,000 pounds initial compression and tables of 1890.	
1,789 1,789	J, 30,660 Navy, 27,000	6	1	6	1	Wind from right and rear, 15°, 32 miles an hour.	Copper cylinders of 24,000 pounds initial compression and tables of 1890 used in J gauge. Copper cylinders of 18,000 pounds initial compression and tables of 1890 used in Navy gauge.	Gun mounted on imitation Krupp carriage. Cylinders filled with oil before firing. Obturating friction primers. Chamber sponged out after each round. Since last firing burrs have been removed from translating roller. A new locking device fitted to face plate and breechblock. Not applied in this firing. Fired to sea. In closing in rotating breechblock last turn and a half made with great difficulty, a rope being attached to handle. Threads of breechblock in breech of gun showed marks of hand bearings. After each round the stop catch in rotating handle was jammed hard against left side of notch in face plate, showing an apparent effort of the block to rotate. Copper cylinders of 32,000 pounds initial compression and tables of 1890 used in rounds 29 to 32, inclusive. Double shrouded pinions for rotating gear fitted in breech mechanism before this firing.
Lost. 1,880	J, 37,000 Navy, 36,090	6	3	6	3		....	
1,922 1,919	J, 38,000 Navy, 37,611	6	4	6	4		....	
Lost. 1,953	Navy, 37,666 J, 40,000	6	4	6	4		....	
Lost. 1,958 200+1⅝°	Navy, 38,500 J, 38,766	6	3	6	3		....	

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing.

Date.	No. of fire.	Powder.			Projectile.		Travel of shot in bore.	Elevation.	
		Kind.	Weight.	Number of prisms.	Kind.	Weight.			
1892. P. M.			*Pounds.*			*Pounds.*	*Inches.*	°	′
May 4	33	Du Pont's brown prismatic, V. P., lot 6; density, 1,840; received April 29, 1892; 79 prisms in cross section.	Front cartridge.. 115 Center cartridge. 115 Rear cartridge... 120 350	Brown.. 1,247 Brown.. 1,243 Brown.. 1,290 Black... 7	Solid shot, lot 317.	996	330.75	0	0
May 4	34		Front cartridge.. 130 Center cartridge. 130 Rear cartridge... 140 400	Brown.. 1,404 Brown.. 1,405 Brown.. 1,508 Black... 7		999	330.75	0	0
May 4	35		Front cartridge.. 150 Center cartridge. 150 Rear cartridge... 150 450	Brown.. 1,622 Brown.. 1,622 Brown.. 1,615 Black... 7		1,000	330.80	0	0
A. M. May 24	36	Du Pont's brown prismatic, V. P., lot 7; density, 1.835; received May 20, 1892.	Front cartridge.. 115 Center cartridge. 115 Rear cartridge... 120 350	Brown.. 1,240 Brown.. 1,240 Brown.. 1,287 Black... 7		1,000	330.30	0	0
May 24	37		Front cartridge.. 130 Center cartridge. 135 Rear cartridge... 135 400	Brown.. 1,401 Brown.. 1,458 Brown.. 1,453 Black... 7		1,000	330.50	0	0
May 24	38		Front cartridge.. 140 Center cartridge. 135 Rear cartridge... 150 425	Brown.. 1,504 Brown.. 1,457 Brown.. 1,613 Black... 7		1,000	330.40	0	0

***Watervliet Arsenal, at Sandy Hook Proving Ground, etc.*—Continued.**

to prove powder.]

Instrumental velocity, 275 feet from muzzle.	Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
								Velocities and pressures taken by Lieut. C. B. Wheeler, Ordnance Department. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer. Gun star gauged before and after firing by Mr. Merchant.
Feet.	*Pounds.*	*Ft.*	*In.*	*Ft.*	*In.*			
1,607 1,605	U, 22,660 Z, 21,835	5	3	5	3	Wind from rear and right, 10°, 4 miles an hour.	In opening in rotating breechblock first turn made with some difficulty. A thick residue in bottom of chamber removed by scraper. Copper cylinders of 18,000 pounds initial compression and tables of 1890.	Gun mounted on Krupp imitation carriage. Cylinders filled with oil. Obturating friction primers. Seats for pressure gauge deepened before this firing. Pressure gauge screwed into seat by hand, a spanner wrench being used to hold the mushroom head. A new bronze stud in tray latch. Fired to sea. Chamber sponged out. Front cup oiled after each round. Elevating gear became unclamped after each discharge. Velocities and pressures taken by Lieut. C. B. Wheeler, Ordnance Department. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.
1,729 1,729	U, 28,170 Z, 28,846	6	8	6	8		Spindle of mushroom head loosened slightly before this round. Copper cylinders of 24,000 pounds initial compression and tables of 1890.	
1,875 1,855 200+1⅝°	U, 34,600 Z, 34,840	6	5½	6	5½		A thick residue in bottom of chamber removed by scraper. Copper cylinders of 28,000 pounds initial compression and tables of 1890.	
1,666 1,661	U, 24,800 Z, 25,520	5	9	5	9	Wind from rear and right, 15°, 6 miles an hour; barometer, 29.98; thermometer, 65°; humidity, 56.	Lower part of second velocity frame cut by shot. Copper cylinders of 18,000 pounds initial compression and tables of 1890.	Gun mounted on Krupp imitation carriage. Cylinders filled with oil, 2¼ gallons added to left and 1¾ gallons added to right cylinder. Chamber sponged out after each round to facilitate loading of projectile. Fired to sea.
1,813 1,806	U, 33,566 Z, 33,566	6	3	6	3		Thick powder scale in bore, necessitating use of battering ram to force shot home. Copper cylinders of 24,000 pounds initial compression and tables of 1890.	
1,892 1,875	U, 37,690 Z, 38,660	6	4	6	4		Copper cylinders of 32,000 pounds initial compression and tables of 1890.	

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing,

Date.	No. of fire.	Powder.			Projectile.		Travel of shot in bore.	Elevation.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.		
1892. A. M.			*Pounds.*			*Pounds.*	*Inches.*	°
May 24	39	Du Pont's brown prismatic, V. P.; lot 8; density, 1.835; received May 20, 1892.	Front cartridge.. 115 Center cartridge. 115 Rear cartridge... 120 350	Brown.. 1,255 Brown.. 1,255 Brown.. 1,302 Black... 7	Solid shot, lot 317.	1,000	330.40	0
May 24	40		Front cartridge.. 130 Center cartridge. 135 Rear cartridge... 135 400	Brown.. 1,418 Brown.. 1,474 Brown.. 1,467 Black... 7		1,000	330.40	0
May 24	41		Front cartridge.. 150 Center cartridge. 150 Rear cartridge... 150 450	Brown.. 1,637 Brown.. 1,637 Brown.. 1,630 Black... 7		1,000	330.40	0
P. M. July 15	42	Du Pont's brown prismatic, V. P., lot 9; density, 1.830; received July 14, 1892.	Front cartridge.. 115 Center cartridge. 115 Rear cartridge... 120 350	Brown.. 1,147 Brown.. 1,147 Brown.. 1,233 Black... 7		1,000	330.80	5
July 15	43		Front cartridge.. 135 Center cartridge. 130 Rear cartridge. . 135 400	Brown.. 1,462 Brown.. 1,409 Brown.. 1,458 Black... 7		999	331	5
July 16	44	Du Pont's brown prismatic, V. P.; lot 10; density, 1.830; received July 14, 1892.	Front cartridge.. 115 Center cartridge. 115 Rear cartridge... 120 350	Brown.. 1,238 Brown.. 1,239 Brown.. 1,288 Black... 7		1,000	330.6	5
July 16	45		Front cartridge.. 135 Center cartridge. 130 Rear cartridge... 135 400	Brown.. 1,456 Brown.. 1,404 Brown.. 1,451 Black... 7		1,000	330.8	5
July 16	46		Front cartridge.. 134 Center cartridge. 134 Rear cartridge... 150 418	Brown.. 1,447 Brown.. 1,447 Brown.. 1,615		999	330.7	5

***Watervliet Arsenal, at Sandy Hook Proving Ground, etc.*—Continued.**

to prove powder.]

Instrumental velocity, 275 feet from muzzle.	Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Feet.	*Pounds.*	*Ft.*	*In.*	*Ft.*	*In.*			
1, 621 1, 613	U, 23, 380 Z, 24, 850	6	1	6	1	Wind from rear and right, 15°, 6 miles an hour; barometer, 29.98; thermometer, 65°; humidity, 56.	Copper cylinders of 18,000 pounds initial compression and tables of 1890.	In opening in rotating breechblock first turn made with some difficulty. Velocities and pressures taken by Lieut. O. M. Lissak, Ordnance Department. Firing conducted by Capt. F. Heath, Ordnance Department, proof officer.
1, 764 1, 761	U, 28, 640 Z, 30, 680	6	6	6	7		Thick powder scale in bore, necessitating use of battering ram to force shot home. Copper cylinders of 24,000 pounds initial compression and tables of 1890.	
1, 909 1, 896	U, 38, 740 Z, 38, 420	6	7	6	5		Copper cylinders of 32,000 pounds initial compression and tables of 1890.	
200+1½°								
1, 712 1, 707	P, 28, 200 X, 26. 030	6	2½	6	2½	Wind from right and front, 30°, 11 miles an hour; barometer, 30.11; thermometer, 80°; humidity, 61.	Copper cylinders of 18,000 pounds initial compression and tables of 1890.	Gun mounted on Krupp imitation carriage. Cylinders filled with oil. Obturating friction primers. Fired to sea. Velocities and pressures taken by Lieut. C. B. Wheeler, Ordnance Department. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.
1, 848 1, 841	P, 37, 120 X, 37, 200	6	4	6	4		In closing in rotating breechblock last turn made with slight difficulty. Copper cylinders of 24,000 pounds initial compression and tables of 1890.	
1, 677 1, 662	M, 26, 700 Z, 26, 157	6	1	6	1	Wind from right and rear, 15°, 12 miles an hour; barometer, 30.07; thermometer, 76°; humidity, 55.	Copper cylinders of 18,000 pounds initial compression and tables of 1890 used.	
1, 787 1, 781	M, 34, 200 Z, 33, 500	6	3	6	3		Battering ram used to force shot home. On bolt on upper lug on worm gear left side broken. Copper cylinders of 28,000 pounds initial compression and tables of 1890 used.	
1, 868 1, 864	M, 34, 880 Z, 35, 940	6	4	6	4		Copper cylinders of 32,000 pounds initial compression and tables of 1892 used.	

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing, test of

Date.	No. of fire.	Powder.			Projectile.		Travel of shot in bore.	Elevation.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.		
1892. A. M.			*Pounds.*			*Pounds.*	*Inches.*	
July 16	47	French smokeless, B. N.	170	....	Solid shot, lot 317.	1,000	330.80	5
July 16	48		204	....		1,000	330.80	5
July 16	49		221	....		999	330.80	5

[Object of firing,

Date.	No. of fire.	Powder Kind.	Weight.	Number of prisms.	Projectile Kind.	Weight.	Travel of shot in bore.	*Depression.*
1892. A. M.								
July 30	50	Du Pont's brown prismatic, V. P., lot 11; density, 1.840; received July 29, 1892.	Front cartridge.. 115 Center cartridge. 115 Rear cartridge... 120 350	Brown.. 1,141 Brown.. 1,141 Brown.. 1,285 Black... 7	Solid shot, lot 317.	1,000	330.8	30
July 30	51		Front cartridge.. 140 Center cartridge. 135 Rear cartridge... 150 425	Brown.. 1,509 Brown.. 1,454 Brown.. 1,612 Black... 7		999	330.9	35

Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

French smokeless powder.]

Instrumental velocity, 275 feet from muzzle.	Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Feet.	*Pounds.*	*Ft.*	*In.*	*Ft.*	*In.*			
1,555 1,541	P, 18,066 X, 16,960	5	9	5	9	Wind from right and rear, 15°, 12 miles an hour; barometer, 30.07; thermometer, 76°; humidity, 55.	Copper cylinders of 9,000 pounds initial compression and tables of 1890 used in gauge X. Copper cylinders of 18,000 pounds initial compression and tables of 1890 used in gauge P.	Gun mounted on Krupp imitation carriage. Obturating friction primers. A black and rather dense smoke issued from the gun at discharge and floated off with the wind for some distance before being dissipated. Fired to sea. Charge of 221 pounds B. N. fills chamber. 2 ounces of rifle powder in disk in bottom of cartridge bag. The blast at discharge is much greater with this powder than with brown prismatic. Velocities and pressures taken by Lieut. C. B. Wheeler, Ordnance Department. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.
1,843 1,831	P, 27,060 X, 25,683	6	1	6	1		Copper cylinders of 18,000 pounds initial compression and tables of 1890.	
2,007 1,992	M, 35,554 Z, 35,900	6	3	6	3		Copper cylinders of 32,000 pounds initial compression and tables of 1892.	
200+$\frac{1}{8}$°								

to prove powder.]

1,549 1,537	M, 20,500 Z, 21,200	5	3	5	3	Wind from rear and right, 15°, 5 miles an hour; barometer, 30.15; thermometer, 82°; humidity, 72.	Copper cylinders of 18,000 pounds initial compression and tables of 1890.	Gun mounted on Krupp imitation carriage. Cylinders filled with oil (6¾ gallons). Obturating friction primers. Fired into new sand butt, Velocities and pressures taken by Lieut. C. B. Wheeler, Ordnance Department. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.
1,755 1,749	M, 29,938 Z, 28,071	6	3	6	3		Copper cylinders of 24,000 pounds initial compression and tables of 1890.	

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons).

[Object of firing, test of French smokeless

Date.	No. of fire.	Powder.			Projectile.		Travel of shot in bore.	Elevation.	
		Kind.	Weight.	Number of prisms.	Kind.	Weight.			
1892.			*Pounds.*			*Pounds.*	*Inches.*	°	'
P. M. Aug. 4	52	Du Pont's brown prismatic, V. P., lot 7; density, 1.835.	Front cartridge.. 115 Center cartridge. 115 Rear cartridge... 120 350	Brown.. 1,247 Brown.. 1,247 Brown.. 1,288 Black... 7	Solid shot, lot 333.	1,000	330.50	0	0
Aug. 4	53	French smokeless, B. N.	Front cartridge.. 85 Center cartridge. 85 Rear cartridge... 34 204	....		1,000	330.50	0	0
Aug. 4	54		Front cartridge.. 85 Center cartridge. 85 Rear cartridge... 34 204	....		999	330.50	0	0

Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

(B. N.) powder when heated to 100° and 120°.]

Instrumental velocity, 275 feet from muzzle.	Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Feet.	*Pounds.*	*Ft.*	*In.*	*Ft.*	*In.*			
1,640 1,663	M, 27,691 Z, 27,400	6	1	6	1	Wind from right and rear, 45°, 6 miles an hour; barometer, 30.10; thermometer, 90°; humidity, 55.	Warming charge	Gun mounted on Krupp imitation carriage. Obturating friction primers. Cylinders filled with oil. Fired to sea. Copper cylinders of 18,000 pounds initial compression and tables of 1890. In heating the powder in tin cans moisture was drawn out and turned the powder a brown color. When dried this disappeared. The sun also turned the color much darker. Velocities and pressures taken by Lieut. F. P. Peck, Ordnance Department. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
1,851 1,847	M, 27,745 Z, 27,436	6	0	6	0		This powder was heated in tin cans placed in water to a temperature of 100° for 1½ hours, the temperature ranging from 98° to 104°. The powder was then put up into cartridges and fired within 2 hours. A cloud of black smoke issued from gun at discharge and floated off for some distance before disappearing.	
1,923 1,916 200+$\frac{15}{2}$°	M, 30,178 Z, 29,545	6	2	6	2		This charge was heated in tin cans placed in water for 3 hours to a temperature of 120°, the temperature ranging from 118° to 123°, the day before firing. The next day it was heated to a temperature of 120° in an oven for ½ hour and then put up in cartridges. The cartridges were put out in the sun until fired, the thermometer in the sun showing 120°. In this discharge there was a very small amount of clay-colored smoke, which disappeared almost immediately after firing. The powder in this case could be called smokeless. The blast was dreadful, extending to a great distance in rear of the gun, breaking windows in the telegraph tower, breaking out window sash on one side of machine shop, and knocking out window frames in new loading shed, knocking out boards on side of cement shed just in rear of traverse in rear of gun.	

Record of firing with 12-inch B. L. rifle (steel), type, No 1 (52 tons),

[Object of firing, test of powder

Date.	No. of fire.	Powder.			Projectile.		Travel of shot in bore.	Elevation.	
		Kind.	Weight.	Number of prisms.	Kind.	Weight.			
			Pounds.			*Pounds.*	*Inches.*	°	
1892. P. M. Aug. 4	55	Du Pont's brown prismatic, V. P., lot 9, density, 1.830; lot 11, density, 1.840.	Lot 9.............. 67 Lot 11............ 67 Front cartridge.. 134 Lot 9.............. 66½ Lot 11............ 66½ Center cartridge. 133 Lot 9.............. 66½ Lot 11............ 66½ Rear cartridge... 133 400	Brown .. 1,448 Brown .. 1,436 Brown .. 1,430 Black ... 7	Solid shot, lot 333.	1,000	330.50	0	0

[Object of firing,

1892. P. M. Aug. 10	56	Du Pont's brown prismatic, V. P., lot 13; density, 1.850.	Front cartridge.. 115 Center cartridge. 115 Rear cartridge... 120 350	Brown.. 1,214 Brown.. 1,214 Brown.. 1,257 Black... 7	Solid shot, lot 333.	998	330.55	0	0
Aug. 10	57		Front cartridge.. 130 Center cartridge. 135 Rear cartridge... 135 400	Brown.. 1,371 Brown.. 1,425 Brown.. 1,418 Black... 7		1,000	330.7	0	0
Aug. 11	58	Du Pont's brown prismatic, V. Y., lot 8; density, 1.830.	Front cartridge.. 115 Center cartridge. 115 Rear cartridge... 120 350	Brown.. 1,349 Brown.. 1,349 Brown.. 1,400 Black... 7		1,000	330.6	0	0
Aug. 11	59	Du Pont's brown prismatic, V. P., lot 12; density, 1.850.	Front cartridge.. 130 Center cartridge. 135 Rear cartridge... 135 400	Brown.. 1,395 Brown.. 1,450 Brown.. 1,443 Black... 7		1,000	330.5	0	0
Aug. 11	60		Front cartridge.. 115 Center cartridge. 115 Rear cartridge .. 120 350	Brown.. 1,235 Brown.. 1,235 Brown.. 1,280 Black... 7		1,000	330.7	0	0

***Watervliet Arsenal, at Sandy Hook Proving Ground, etc.*—Continued.**

blended from V. P., lots 9 and 11.]

Instrumental velocity, 275 feet from muzzle.	Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Feet.	*Pounds.*	*Ft.*	*In.*	*Ft.*	*In.*			
1,792 1,783	M, 32,100 Z, 32,033	6	3	6	3	Wind from right and rear, 45°, 6 miles an hour; barometer, 30.10; thermometer, 90°; humidity, 55.	The gun had been fired 3 times before this round, so no warming charge was fired.	Gun mounted on Krupp imitation carriage. Obturating friction primers. Fired to sea. Copper cylinders of 32,000 pounds initial compression and tables of 1890. This charge was blended by making every other layer of the same kind of powder. Velocity and pressure taken by Lieut. F. P. Peck, Ordnance Department. Firing conducted by Lieut. C. B. Wheeler, assistant proof officer.
200+1½°								

to prove powder.]

Instrumental velocity, 275 feet from muzzle.	Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
1,773 1,761	A, 29,846 M, 29,200	6	3	6	3	Wind from front, 9 miles an hour; barometer, 30.03; thermometer, 90°; humidity, 65.	Copper cylinders of 18,000 pounds initial compression and tables of 1890.	Gun mounted on Krupp imitation carriage. Obturating friction primers. Fired to sea. Chamber washed out after each round to permit starting of projectile.
1,928 1,916	B, 35,812 M, 36,100	6	6	6	6		Battering ram used to force shot home. Copper cylinders of 24,000 pounds initial compression and tables of 1890.	
1,668 1,656	A, 30,981 M, 32,309	6	1	6	1	Wind from front, 13 miles an hour; barometer, 30.14; thermometer, 90°; humidity, 65.	Copper cylinders of 18,000 pounds initial compression and tables of 1890.	Front buffer compressed about 1 inch when gun is in battery. Obturating friction primers. V. P., lot 12, was by the Du Ponts supposed to be a slow powder. Fired to sea.
1,841 1,824	B, 43,320 M, 45,222	6	4	6	4		Part of canvas covering of gas-check pad protruded above front cup. Pad cut by gas. Copper cylinders of 24,000 pounds initial compression and tables of 1890.	
1,705 1,685	A, 34,840 M, 35,527	6	3	6	3		In closing in rotating breech-block last 2 turns made with difficulty. Copper cylinders of 32,000 pounds initial compression and tables of 1890.	

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing.

Date.	No. of fire.	Powder.			Projectile.		Travel of shot in bore.	Elevation.	
		Kind.	Weight.	Number of prisms.	Kind.	Weight.			
1892. P. M.			*Pounds.*			*Pounds.*	*Inches.*	°	′
Aug. 11	61	Du Pont's brown prismatic, V. Y., lot 3; density 1.830.	Front cartridge.. 120 Center cartridge. 125 Rear cartridge... 135 380	Brown.. 1,497 Brown.. 1,464 Brown.. 1,577 Black... 7	Solid shot, lot 333.	1,000	330.6	0	0
Aug. 11	62	Du Pont's brown prismatic, V. P., lot 13; density, 1.850.	Front cartridge.. 130 Center cartridge. 131 Rear cartridge... 145 406	Brown.. 1,372 Brown.. 1,382 Brown.. 1,525 Black .. 7		1,000	330.6	0	0

Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

to prove powder.]

Instrumental velocity, 275 feet from muzzle.	Pressure per square inch or bore.	Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Feet.	*Pounds.*	*Ft. In.*	*Ft. In.*			
1,750 1,745	B, 38,109 M, 38,054	6 3	6 3	Wind from front, 13 miles an hour; barometer, 30.14; thermometer, 90°; humidity, 65.	In closing in rotating breechblock last turn made with difficulty. Copper cylinders of 32,000 pounds initial compression and tables of 1890.	Round 62: This charge, from calculations made from charge of 400 pounds of this powder, was supposed to give limit of pressure. Velocities and pressures taken by Lieut. F. P. Peck, Ordnance Department. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer. Gun star gauged after round 62, Sept. 2, 1892, by Lieut. C. B. Wheeler, Ordnance Department.
2,001 1,991	A, 62,212 M, 60,594	......	......		Same difficulty in closing breechblock as in previous round. Copper cylinders of 32,000 pounds initial compression and tables of 1890. After this round breechblock could not be opened. The face plate was taken off and the gears were found to be all right. A jack was then applied to the rack in breechblock, but this failed to turn it. When a clevis and long bar was added to this arrangement, the clevis bearing in the handles of the breechblock, the block was rotated and taken out. Every thread of the breechblock, with the exception of the first of each sector, showed plainly the print of the threads in the gun. The block was otherwise uninjured. The threads in both breechblock and gun can be repaired by rubbing down with fine emery cloth.	
200+1½°						

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing, proof of powder and

Date.	No. of fire.	Powder.			Projectile.		Travel of shot in bore.	Elevation.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.		
1892.			*Pounds.*			*Pounds*	*Inches.*	° ′
P. M. Sept. 12	63	Du Pont's brown prismatic, V. P., lot 14; density, 1.840.	Front cartridge.. 100 Rear cartridge... 100 200	Brown.. 1,055 Brown.. 1,048 Black... 7	Solid shot, lot 333.	1,000	330.70	3 25
Sept. 12	64		Front cartridge.. 150 Rear cartridge... 150 300	Brown.. 1,584 Brown.. 1,577 Black... 7		975	330.65	0 5

Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

test of Schneider gun carriage.]

Instrumental velocity, 275 feet from muzzle.	Pressure per square inch of bore.	Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Feet.	*Pounds.*	*Ft. In.*	*Ft. In.*			Gun mounted on Schneider carriage on lift in new gun-lift battery. Obturating friction primers. After last firing breechblock and cups were carefully examined. Diameter of spindle under pad 4.94 inches; largest diameter of spindle 4.955 inches. The spindle was scored all the way around under place of rear cup by escape of powder gas to the rear, and the front portion of under bearing surface of rear cup also scored all the way around. Two scores on the spindle are 0.07 inch deep. All the scoring seem caused by a slight fusion of metal where the gas escaped. Fired into sea. 36 gallons of oil put in cylinders just before firing, making 46 gallons in all. The first packing that was put in cylinders (rubber packing sent with carriage) did not work well and was removed before round 64. The cylinders were packed with asbestus packing, as other cylinders at this post. The gun would not run into battery by action of gravity alone when by-pass valve was opened and had to be pushed in each time by wooden levers and handspikes. Uncompressed copper cylinders and tables of 1890 used in gauge M and 9,000 pounds coppers of 1890 in gauge A in round 63. Velocities and pressures taken by Lieut. F. P. Peck, Ordnance Department. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
....	M, 15,185 A, 14,673	......	......	Wind from right and rear, 18 miles an hour; barometer, 30.38; thermometer, 72°; humidity, 61.	First primer failed to ignite charge, due to oil in vent. The by-pass valve did not close entirely, permitting carriage to run part way into battery. The rails and guides are a very close fit, and this, together with the new packing, probably prevented its running all the way into battery. The by-pass valve did not work in this round, due to burrs on the rod around which the spring is coiled. The valve is pushed to its seat by a spring and opened by an eccentric, and although the eccentric was turned properly burrs prevented spring from acting, and this was not discovered, although valve was examined just before firing. A method of marking recoil was not used, as it was thought carriage would remain where it stopped. However, it was seen to recoil very close to buffers. Shot calipered 11.94 inches.	
1,637 1,641 200+$^{1}{}_{5}{}^{9}$	A, 23,729 M, 22,692	......	......		In this round by-pass valve was repaired and worked properly. Gun recoiled and compressed buffers 1½ inches, and had a counter recoil of the same distance. Check valve worked properly and held it out of battery. Copper cylinders of 9,000 pounds initial compression and tables of 1890 used in gauge A, and 18,000 pounds copper in gauge M.	

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing, test of carriage on lift to see

Date.	No. of fire.	Powder.			Projectile.		Travel of shot in bore.	Elevation.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.		
1892.			*Pounds.*			*Pounds.*	*Inches.*	°
A. M. Nov. 22	65	Du Pont's brown prismatic, V.P., lot 14; density, 1.840.	200	Brown .. 2,105 Black ... 7	Solid shot, lot 333.	996	330.65	2
P. M. Nov. 22	66	Du Pont's brown prismatic, V.P., lot 10; density, 1.830.	200	Brown .. 2,146 Black ... 7		1,000	Not taken.	2
Nov. 22	67	Du Pont's brown prismatic, V.P., lot 15; density, 1.840.	Front cartridge .. 115 Center cartridge. 115 Rear cartridge ... 70 300	Brown .. 1,440 Brown .. 1,440 Brown .. 751 Black ... 7		1,000	Not taken.	....

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons), Watervliet

[Object of firing, test of carriage

Date.	No. of fire.	Powder.			Projectile.		Observed time of flight.	Travel of shot in bore.	Elevation.	Instrumental velocity, 275 feet from muzzle.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
1892.			*Pounds.*			*Pounds.*	″	*Inches.*	°	*Feet.*
Nov. 23	68	Du Pont's brown prismatic, V. P., lot 15; density, 1.840.	150 175 325	1,618 1,880 7	Solid shot, lot 333.	1,002	....	330.60	0	1,658 1,658
Nov. 23	69		105 130 140 375	1,132 1,402 1,504 7		998	....	Not taken.		1,796 1,798 200 + $\frac{159}{2}$
Nov. 28	70	Du Pont's brown prismatic, V. P., lot 10; density, 1.830.	150 50 175 375	1,618 541 1,881 7		993	17½	330.75	10	....

Watervleit Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

whether throttling bars worked properly.]

Instrumental velocity, 275 feet from muzzle.	Pressure per square inch of bore.	Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Feet.	*Pounds.*	*Ft. In.*	*Ft. In.*			
....	M, 14,904 Z, 14,881	5 11	0 1⅛	Wind from rear, 25 miles an hour; barometer, 30.20; thermometer, 40°; humidity, 52	....	
....	P, 9,857 X, less than 9,000	5 11	0 1⅛		....	
....	P, 22,600 X, 23,018	5 11½	0 1⅛		....	

Arsenal, at Sandy Hook Proving Ground, from November 23, 1892, to April 24, 1893.

on lift, and proof of powder.]

Pressure per square inch of bore.	Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft. In.*	*In.*			
P, 24,600 X, 25,500	5 11	1⅛	Wind from rear, 23 miles an hour.	18,000 coppers of 1890	Gun mounted on Schneider carriage on lift in new gun-lift battery. Obturating friction primers. Shot gauged before firing. Fired to sea. Before this firing 5 gallons of mixture (glycerin and water) removed, and 5 gallons pure glycerin added to cylinders. Time required to traverse carriage 180° with 4 men, 2 minutes; no stop. Time required to traverse carriage 360° with 4 men, 4 minutes 36½ seconds; no stop. Time required to elevate gun from 0° to 10° with 4 men, 43 seconds; no stop. Time required to elevate gun from 0° to 19° 40′ with 4 men (not including 2 stops), 2 minutes 45 seconds.
P, 30,182 X, 30,182	5 11⅜	1⅛		Gun in recoiling compressed buffers ¾ inch. Breechblock in rotating worked hard in closing and opening. 24,000 coppers of 1890.	
P, 27,418 X, 28,043	5 11	1⅛		Same difficulty with breechblock as in previous round. In running gun into battery, long lever used to start it.	

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing, test of carriage

Date.	No. of fire.	Powder.			Projectile.		Observed time of flight.	Travel of shot in bore.	Elevation.		Instrumental velocity, 275 feet from muzzle.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.					
			Pounds.			*Pounds.*	"	*Inches.*	°	′	*Feet.*
1892. Nov. 30	71	Du Pont's brown prismatic, V. P., lot 15.	200	2, 151 7	Solid shot, lot 333.	997	....	330. 7	10	0	....
Nov. 30	72	Du Pont's brown prismatic, V. P., lot 14.	130 130 130 390	1, 372 1, 372 1, 365 7		995	....	330. 8	0	0	1, 915 Lost. 200 + $\frac{1}{2}$°
Nov. 30	73	Du Pont's brown prismatic, V. P., lot 11.	150 150 160 460	1, 615 1, 615 1, 715 7		1, 000	27	331. 1	15	0	....
Dec. 1	74	Du Pont's brown prismatic, V. P., lot 6.	150 150 160 460	1, 622 1, 622 1, 724 7		1, 000	34	330. 8	19	40	....
Dec. 1	75	Du Pont's brown prismatic, V. P., lot 15.	123 150 150 423	1, 327 1, 618 1, 611 7		1, 000	....	331	0	0	1, 912 1, 920

Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

on lift, and proof of powder.]

Pressure per square inch of bore.	Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft. In.*	*In.*			
P, 12,690 X, 11,333	5 7½	⅜	Wind from right and rear, 25 miles an hour; barometer, 30.05; thermometer, 32°; humidity, 80.	Warming charge. In running gun into battery long lever used to start it. Recoil allowed on piston, 6 feet 25 inches. First primer failed. The cartridge bag was badly broken by the hydraulic rammer, and some of the prisms were broken and some lost. The miss fire was due to loss of black prisms, as none were added to replace them. Uncompressed coppers of 1890, gauge P; 9,000 coppers of 1890, gauge X.	Gun mounted on Schneider carriage on lift in new gun-lift battery. Obturating friction primers. Fired to sea. Before this firing 20 gallons of mixture (glycerin and water) was removed from cylinders and 20 gallons of pure glycerin added. Tray latch held with rope. The motion of the hydraulic rammer is very slow and does not force the projectile to its seat as well as a wooden rammer handled by 7 or 8 men. It is planned to double velocity of the rammer. Velocities taken by Lieut. F. P. Peck, Ordnance Department. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
M, 39,943 Z, 41,060	5 8 1/16	1/16		Recoil allowed on piston, 6 feet 13/16 inch. 32,000 coppers of 1890.	
M, 33,400 Z, 32,050	5 8 13/16	0		Recoil allowed on piston, 6 feet 13/16 inch. In closing in rotating breechblock last turn made with great difficulty. Gas-check pad cut very badly in rear, asbestus and canvas squeezed between spindle and block. 32,000 coppers of 1890.	
M, 33,433 Z, 32,139	5 8 7/16	0	Wind from right and rear, 23 miles an hour; barometer, 30.08; thermometer, 35°; humidity, 54.	Recoil allowed on piston, 6 feet 13/16 inch. 32,000 coppers of 1890.	Gun mounted on Schneider carriage on lift in new gun-lift battery. Obturating friction primers. Fired to sea. Shot gauged before firing. 19° 40′ all the elevation allowed. 5 feet 7½ inches from bottom of cylinder to highest point of carriage. 7 feet 1⅜ inches widest part of carriage.
M, 34,055 Z, 33,500	5 9 11/16	0		Recoil allowed on piston, 6 feet 13/16 inch. 32,000 coppers of 1890. 19° 40′ is the greatest elevation which the carriage permits, as the gun strikes the rear transom of top carriage. This can be chipped away so that 20° can be obtained. Bonnet-protecting rollers removed and roller path and rollers thoroughly cleaned and oiled. After this the carriage traversed much more easily, so that 2 men could move it, and 3 with ease. The gun elevates with great difficulty, requiring at least 4 men. This is due to the close fit of worm and gears, the teeth of gear bearing hard against bottom of grooves of worm. This can be remedied by taking off and filing bearing surfaces.	

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing, to test

Date.	No. of fire.	Powder.			Projectile.		Observed time of flight.	Travel of shot in bore.	Elevation.	Instrumental velocity, 275 feet from muzzle.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
			Pounds.			*Pounds.*		*Inches.*	° '	*Feet.*
1892. Dec. 1	76	French smokeless, B. N.	85 84 85 204	....	Solid shot, lot 333.	999	....	330. 55	0 0	1, 951 1, 943 $200+\frac{150}{2}$

[Object of firing.

Date.	No. of fire.	Powder Kind.	Powder Weight.	Number of prisms.	Projectile Kind.	Projectile Weight.	Observed time of flight.	Travel of shot in bore.	Elevation.	Instrumental velocity, 275 feet from muzzle.
1893. Mar. 14	77	Du Pont's brown prismatic, V. P., lot 15.	115 120 120 355	1, 241 1, 241 1, 287 7	Solid shot, lot 333.	999	....	330. 4	0 25	1, 743 1, 755
Mar. 15	78		130 135 135 400	1, 403 1, 455 1, 451 7		999	....	330. 4	0 25	1, 902 1, 906
Mar. 15	79		90 150 150 390	971 1, 619 1, 612 7		999	....	330. 35	0 25	1, 834 1, 852 $200+\frac{150}{2}$
Mar. 31	80	Du Pont's brown prismatic, V. P., lot 16.	115 115 120 350	1, 238 1, 238 1, 288 7		1, 000	....	330. 5	0 20	Lost.
Mar. 31	81		130 135 135 400	1, 401 1, 457 1, 457 7		1, 002	....	330. 6	0 25	1, 847 1, 845
Mar. 31	82		120 150 150 420	1, 293 1, 618 1, 611 7		1, 002	....	330. 6	0 15	1, 920 1, 926

Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

French smokeless powder.]

Pressure per square inch of bore.	Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds. M, 27,277 Z, 28,800	*Ft. In.* 5 7$\frac{11}{16}$	*In.* 0	Wind from right and rear, 23 miles an hour; barometer, 30.03; thermometer, 35°; humidity, 54.	Powder stored in ordinary powder barrels since August 5, 1892. 24,000 coppers of 1890, gauge M; 28,000 coppers of 1890, gauge Z. The blast, especially to the rear, quite severe. There was not much smoke at discharge. What there was seemed to be mixed with a quantity of concrete dust from the parapet and was soon dissipated.	

proof of powder.]

Pressure per square inch of bore.	Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
A, 27, 160 X, 27, 180	5 2	¼	Barometer, 29.90; thermometer, 46°; humidity, 72.	Gun 2¼ inches out of battery when fired. 18,000 coppers of 1890. 128 pounds of this charge made from lot received Oct. 1, 1892, and 222 pounds from lot received Dec. 16, 1892.	Gun mounted on Schneider carriage on lift in new gun-lift battery. 41½ gallons of pure glycerin put in cylinders. Obturating friction primers. Fired to sea. Tray latch held with rope. The copper pin which acts against tray latch is so small in diameter that the end is cut off by slots in translating roller; this prevents translation of block and allows tray to move while breechblock is being moved into the gun. The friction gear for elevating did not work satisfactorily; the nuts had to be set up for the last round. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
P, 42, 000 Z, 42, 000	5 4	⅛		24,000 coppers of 1890	
A, 35, 000 X, 34, 600	5 4	¼		In closing in rotating breechblock, 6 men on handle. This was due to the sticking of cups. Friction elevating gear would not work.	
P, 27, 545 Z, 27, 800	5 2	....	Wind from left and rear, 11 miles an hour; barometer, 30.04; thermometer, 56°; humidity, 60.	After firing carriage ran nearly into battery, due to valve in force pump being clogged and not acting. Pump valve unseated and cleaned before next round. Wires of second velocity frame not cut. 24,000 coppers of 1890.	Gun mounted on Schneider carriage on lift in new gun-lift battery. Obturating friction primers. Reservoir was found full of water. This was drained out before firing and the reservoir filled with 2½ gallons of mixture of glycerin and water, 1 to 1. In running the gun into battery before the firing commenced the breechblock was left open, the console caught on the side of the carriage and broke off the latch which holds breech mechanism open. Before firing burrs removed from translating roller and rear cup smoothed off. Fired to sea. The tray latch was held in place by a small wooden wedge placed between console and latch and lashed with rope. Firing conducted by Lieut. E. St. J. Greble, Second Artillery.
P, 34, 800 Z, 34, 500	5 4	....		First cartridge broke up in going into gun, about 20 prisms loose in chamber. 24,000 coppers of 1890.	
P, 45, 200 Z, 42, 800	5 6	....		32,000 coppers of 1890	

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing,

Date.	No. of fire.	Powder.			Projectile.		Observed time of flight.	Travel of shot in bore.	Elevation.	Instrumental velocity, 275 feet from muzzle.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
			Pounds.			*Pounds.*		*Inches.*		*Feet.*
1893. P. M. Apr. 24	83	Du Pont's brown prismatic, V. P., lot 17.	115 115 120 350	1,234 1,234 1,281 7	Solid shot, lot 333.	1,002	....	330.3	15	1,913 1,922

Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

roof of powder.]

Pressure per square inch of bore.	Recoil.	Counter recoil.	Wind, strength and direction.	General remarks.
Pounds. A, about 73,800 X, about 73,400	*Ft. In.* 5 6	*In.* 1⅛	Barometer, 30.20; thermometer, 54°; humidity, 53.	Gun mounted on Schneider carriage on lift in new gun-lift battery. Obturating friction primers. Fired to sea. Before this firing breechblock was removed and edges of threads at slotted sectors, which had upset over edges of slotted sectors, brought back to their original shape. The lips of the cups were turned down and steel split rings placed on spindle against rear cup only and copper rings on pad. Body of spring-lock bolt was enlarged to 1.44 inches and the collar on shoulder to 1.84 inches. The location of center of hole was moved to the front 0.125 inch in order to let bolt pass translating roller. Latch for holding block open repaired. Nut holding handle of new locking device on face plate broken. Copper cylinders of 24,000 pounds initial compression and tables of 1890 were used to determine the pressure. In gauge A: Original length, 0.4091 inch; after firing, 0.1875 inch; compression, 0.2216 inch. In gauge X: Original length, 0.4095 inch; after firing, 0.1891 inch; compression, 0.2204 inch. According to the table the compression of these coppers for a pressure of 60,000 pounds (the limit of table) would be 0.1725 inch. The steel springs used for centering the copper were crushed and broken to pieces in both gauges. In one the copper and spring were crushed together so as to make it difficult to separate them. The following operations were tried in attempts to open the breechblock after this round: The locking bolt on spindle was unscrewed and the center friction washer taken off. A machine steel bar, 4 by 1 by 6 feet long, was put under the handle on the block and fastened by lugs and 4 1-inch bolts. A 30-ton jack was applied under the end of bar without starting the block. Attempts had previously been made to drive the block ahead by the use of a 200-pound rammer, by two 30-ton jacks, and by use of screws. The face plate was then removed and a 30-ton jack put under the rotating ring, a 7-ton jack under the lever through the handles, and a 14-pound sledge used against a copper drift applied to the slot for the locking key. This combination started the block. After the block was removed, the spindle, mushroom cups, and pad were knocked out from in front. The screw threads on breechblock were set up and strongly marked. The nose of the block was upset and completely filled the gas-check seat. In rear of this seat, back to the fillet, it (the nose) was upset and rounded like the sides of the copper cylinders used in the pressure plugs after a high pressure. The spindle where the pad seats was contracted about 0.125; the pad had cut in front and asbestus and copper was forced over the front cup into the bore of the gun. The front cup was so hard that it could not be touched by a file. The face of the mushroom head was slightly concaved to the front and the two gauges were practically ruined. The front cup was not enlarged; the rear cup was enlarged to more than fill the seat. The hole through the breechblock for the spindle had upset in front end to nearly the diameter of the spindle. The gas-check seat in the bore of the gun was enlarged over front cup about 0.035 inch; over pad, about 0.045 inch; over rear cup, about 0.02 inch. Firing conducted by Lieut. E. St. J. Greble, Second Artillery.

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons), Watervliet

[Object of firing,

Date.	No. of fire.	Powder.			Projectile.		Shot marked.	Travel of shot in bore.	Depression.		Instrumental velocity, 275 feet from muzzle.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.					
1893.			*Pounds.*			*Pounds.*		*Inches.*	°	′	*Feet.*
May 31	84	Du Pont's brown prismatic, V. P., lot 18; density, 1.845.	116	1,259	Solid shot, lot 333.	1,000	1	330.6	2	35	1,700 Not reliable.
			117	1,271							
			117	1,264+7							
			350								
May 31	85		133	1,446		1,000	2	330.6	2	35	1,814 1,801
			133	1,445							
			134	1,448+7							
			400								
May 31	86		150	1,629		1,000	3	330.7	0	12¼	1,917 1,903
			120	1,311							
			150	1,622+7							200 + $\frac{15}{2}$°
			420								

Arsenal, at Sandy Hook Proving Ground, from May 31, 1893, to April 10, 1894.

to prove powder.]

Pressure per square inch of bore.	Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft. In.*	*Ft. In.*			Gun mounted on Schneider carriage on lift in new gun-lift battery. Fired into sand butt, rounds 84 and 85. Obturating friction primers. Shot gauged before firing. 1 quart of pure glycerin added to cylinders before firing, filling them. Previous to this firing a round of 122 pounds of this lot was fired in 8-inch B. L. rifle; pressure, 23,920 pounds. Velocity not recorded. Since last firing breechblock removed, and hole for larger end of spindle of block enlarged from 4.959 inches to 4.999 inches. Original length of block was 24.75 inches; after round 83 shortest part was 24.638 inches. Faced off high parts of block to make it same length. Breechblock was upset 0.04 inch. It was turned down to the original size, 14.99 inches. All threads of block filed, and edges of slotted sectors rounded. Front cup was left the same in diameter as after round 83, 14.195 inches. Rear cup had expanded 0.02 inch; it was turned to 14.4617 inches. The lips of the front cup turned down to 0.56 inch in thickness, and upper edge to ⅛ inch for the depth of 1.25 inches. Two split rings made to take the place of lips on cups, as per drawing. Threads on inside of gun scraped and filed; edges of slotted sectors rounded. Filed off rough parts of gas-check seat. Lieutenant Peck, Ordnance Department, is of the opinion that the poor working of velocity instruments was due to the tubes on chronographs not being cylindrical. Velocity taken by Lieut. F. P. Peck, Ordnance Department. Firing conducted by Lieut. E. St. J. Greble, Second Artillery.
A, 25,350 P, 25,400	5 7⅛	0 ½	....	The shot struck in front of butt and ricochetted over butt and struck in water. 18,000 coppers of 1890.	
A, 32,000 P, 31,850	5 8⅛	0 ⅛	....	The shot struck in front of butt and ricochetted through, fell in the water. 24,000 coppers of 1890.	
36,600 37,200	5 8⅛	0 ⅛	....	Fired to sea. 32,000 coppers of 1892.	

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing, exhibition of gun before

Date.	No. of fire.	Powder.			Projectile.		Shot marked.	Travel of shot in bore.	Elevation.	Instrumental velocity.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
			Pounds.			*Pounds.*		*Inches.*	° ′	
1893. July 13	87	Du Pont's brown prismatic, V. P., lot 8.	450 0	....	Solid shot, lot 344.	1,002½	....	330.3	10 0	....
July 13	88	Du Pont's brown prismatic, V. P., lot 9.	400 0	4,322	Solid shot, lot 333.	1,002	....	Not taken.	3 0	....

***Watervliet Arsenal, at Sandy Hook Proving Ground, etc.*—Continued.**

the Board of Ordnance and Fortification.]

Pressure per square inch of bore.	Recoil.	Counter recoil.	Wind strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft. In.*	*Ft. In.*			
A, 37,200 B, 34,840	5 10½	5 11¼	Barometer, 29.96; thermometer, 90°; humidity, 100.	Carriage in returning to firing position compressed front buffers 1 inch.	Gun mounted on Schneider carriage on lift in new gun-lift battery. 47½ gallons of pure glycerin in cylinders. Obturating friction primers. 32,000 coppers of 1890. Fired to sea. Since last firing a platform has been attached to the carriage for the gunners to stand on in loading the gun. When the gun is elevated to the position for loading the platform is sufficiently high to permit easy manipulation of the rotating handle; this is not the case, however, for any less elevation. **The check valve allows the gun to return to battery after the** first round, but seated itself again as soon as the gun stopped its counter recoil, so that it could be pumped from battery to loading position. After the second round the valve allowed the gun again to return into the battery, and the housing for the valve had to be tapped with a hammer to seat the valve. After this round the check valve was taken out and examined, and it was found that the end of the spring spindle of the valve had struck the end of the recess in the cap of the housing sufficiently hard to upset it, and the binding of the surfaces was so great that the spring would not get to seat the valve. The surface of the spindle was smoothed off, and also the recess, so that the valve worked freely. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, in the presence of the Board of Ordnance and Fortification. Present: General Scofield, Gen. H. L. Abbott, Col. H. W. Closson, Maj. C. Comly, Capt. C. C. Morrison, Mr. B. W. Cutcheon.
A, 33,300 B, 32,877	5 10½	5 11¼		Carriage in returning to firing position compressed front buffers 1 inch.	

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing, test of

Date.	No. of fire.	Powder.			Projectile.		Shot marked.	Travel of shot in bore.	Depression.	Instrumental velocity, 275 feet from muzzle.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
			Pounds.			*Pounds.*		*Inches.*	′	*Feet.*
1893. July 21	89	Du Pont's brown prismatic, V. P., lot 9.	400	4,328	Solid shot, lot 333.	1,000	....	330.1	20	1,865 1,865
July 25	90	French smokeless, B. N.	197[illegible] [illegible]	.... Igniter.		1,000	....	330.2	20	1,906 1,917
					Solid shot, lot 344.					

Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

French smokeless powder.]

Pressure per square inch of bore.	Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds. D, 35,040 V, 34,400	*Ft In.* 5 $10\frac{1}{8}$	*Ft In.* 5 $11\frac{1}{8}$	Barometer, 30.15; thermometer, 87°; humidity, 54.	After this round the gun returned into battery and it was found that the spindle of the check valve had struck the bottom of the recess in cap of valve housing so hard that it was set up against the surface of the recess, so that a block of wood was required to knock them apart. The spindle and recess were smoothed off and a washer put on top of the spring so as to prevent the head of the spindle from striking the bottom of the recess. The pump failed to work properly after this round, and when taken apart a portion of the rubber washer was found in one of the barrels of the pump, closing one of the ports. When this was removed the pump worked properly.	Gun mounted on Schneider carriage on lift in new gun-lift battery. Obturating friction primers. Fired to sea. 32,000 coppers of 1892 in round 89. 24,000 coppers of 1890 in round 90. The carriage worked very well during this firing. The recoil was checked properly and the carriage remained out of battery after the recoil. Pressures and velocities taken by Lieut. F. P. Peck, Ordnance Department. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department.
D, 30,400 V, 27,600	5 7	0 0	Barometer, 30.10; thermometer, 88°; humidity, 49.	Powder stored in ordinary powder barrels since Aug. 5, 1892. The powder shrunk in weight during storage from 200 pounds to 197 pounds 6 ounces. In appearance it seemed to be the same. The discharge was practically smokeless. A great flame shot out from the muzzle for about 25 feet, and men standing about 50 feet in rear said that the heat was very perceptible. The blast was much stronger than that of brown powder.	
			Barometer, 30.16; thermometer, 85°; humidity, 53.		Gun mounted on Schneider carriage on lift in new gun-lift battery. Obturating friction primers. Fired to sea. This powder has been stored in hermetically sealed cases since August 5, 1892. When opened there was an odor of ether, although not as pungent as when packed, and the magazine sergeant stated that it did not give him a headache as it did when the powder first came. In appearance the powder was unchanged. At discharge a mass of flame darted out from gun for about 30 feet, accompanied by the finest kind of black soot, which soon dissipated. The concrete parapet was blackened with the soot within the range of the blast, differing in this respect

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing, test of

Date.	No. of fire.	Powder.			Projectile.		Shot marked.	Travel of shot in bore.	Depression.	Instrumental velocity, 275 feet from muzzle.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
1893. P. M.			*Pounds.*			*Pounds.*		*Inches.*	′	*Feet.*
Aug. 8	91	French smokeless, B. N.	204	....	Solid shot, lot 344.	1,000	....	330	5	1,882 1,888 200+1½°

[Object of firing, exhibition

									Elevation. ° ′	
1893. Sept. 13	92	Du Pont's brown prismatic, V. U., lot 16.	375	....	Solid shot, lot 344.	1,002	....	330	10 0	....

Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

French smokeless powder.]

Pressure per square inch of bore.	Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft. In.*	*Ft. In.*			
A, 26,600 D, less than 24,000	5 8¾	....	Barometer, 30.16; thermometer, 85°; humidity, 53.	24,000 coppers of 1890........	in a marked degree from the shot with powder which was stored in ordinary powder barrels, when no discoloration of the parapet was noticed. For a minute or two after the discharge a thick whitish colored smoke rolled out of the muzzle, and thinking it might possibly be due to a portion of the cartridge bag smoldering in the bore the officer in charge of the firing inhaled the smoke and was struck with a peculiar ether-like odor. A few moments after this he was seized with a violent headache, which lasted an hour or more. The bore and chamber were covered with the fine soot above mentioned, some of which rubbed off on the hand, leaving a peculiar brownish color, giving appearance of great heat on the metal. With the exception of the fine coating of soot the gun was clean after the discharge. The blast was something extraordinary. Ashes from the furnace in the gun lift were drawn up through the chimney, and a window was broken in the brick house. The heat from the gas could be distinctly felt 50 or 60 feet from the gun. The principal difference between the discharge of this powder and that stored in ordinary powder barrels was that the smoke of the latter was like steam, while the former was black; this, however, was soon dissipated, and, with this exception, the powder was smokeless. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department.

before the Chief of Engineers.]

M, 32,000 N, 34,100	....	....	Barometer, 30.40; thermometer, 70°; humidity, 79.	28,000 coppers of 1890........	Gun mounted on Schneider carriage on lift in new gun-lift battery. Obturating friction primer. Fired to sea. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department.

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing,

Date.	No. of fire.	Powder.			Projectile.		Shot marked.	Travel of shot in bore.	Elevation.	Instrumental velocity, 275 feet from muzzle.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.				
1893.			*Pounds.*			*Pounds.*		*Inches.*	° ′	*Feet.*
Nov. 16	93	Du Pont's brown prismatic, V. P., lot 24.	100 100 100 300	1,059 1,059 1,052+7	Solid shot, lot 344.	1,003½	....	330.2	9 0	....
									Depression. ° ′	
Nov. 17	94		117 117 116 350	1,239 1,239 1,221+7		1,000	....	330.5	2 46½	Lost.
Nov. 17	95		150 150 125 425	1,589 1,589 1,317+7		1,000	....	330.5	2 46½	1,851 1,844
Nov. 17	96		134 166 133 433	1,421 1,756 1,401+7		1,002	....	330.5	2 46½	1,850 1,841 200+½
1894. Jan. 20	97	Du Pont's brown prismatic, W. R.	116 117 117 350	1,209 1,220 1,213+7		1,001	....	330	2 40	1,688 1,684
Jan. 20	98		133 134 133 400	1,384 1,396 1,376+7		1,000	....	330	2 46	1,882 1,887
Jan. 20	99	Du Pont's brown prismatic, W. Q.	117 116 117 350	1,210 1,199 1,203+7		998	....	330	2 41½	1,566 1,564
Jan. 20	100		133 158 134 425	1,374 1,630 1,378+7		1,001	....	330	2 47	1,821 1,820

Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

to prove powder.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			
F, 18,000 G, 18,000	5	5	0	10	Barometer, 30.17; thermometer, 54°; humidity, 64.	The gun in counter recoiling started to move into battery and seemed to have acquired considerable velocity before it was brought suddenly to a stop. 14,000 coppers of 1892.	Gun mounted on Schneider carriage on lift in new gun-lift battery. Obturating friction primers. Fired to sea, round 93; fired into sand butt on beach, rounds 94 to 96, inclusive. Cylinders filled with arctic valve oil No. 2. New throttling bars put in before the firing of Nov. 16. The pump piston was packed before the firing of Nov. 17. Although the friction elevating gear was tightened as much as possible with a wrench, the breech of the gun moved down slightly when the projectile was pushed into the chamber. The depression given by French quadrant is about right for sand butt on beach. The projectile strikes near the ground. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department.
F, 23,080 G, 23,040	5	6	0	7	Barometer, 30.06; thermometer, 38°; humidity, 50.	Wires of second-velocity frame not cut. 18,000 coppers of 1890.	
F, 36,880 G, 37,055	5	7½	0	4½		Pumped back to loading position. The pump, although double acting, only worked on one side. 28,000 coppers of 1890.	
F, 36,600 G, 36,825	5	7	0	1		32,000 coppers of 1892. The powder was not entirely consumed. With the exceptions noted, the carriage worked satisfactorily. The breech mechanism worked very satisfactorily.	
D, 27,000 H, 27,550	5	7	5	7	Wind calm; barometer, 30.67; thermometer, 36°; humidity, 48.	Check valve did not act, and gun returned to firing position. 18,000 coppers of 1892. Shot came out of butt and fell on beach to the right.	Gun mounted on Schneider carriage on lift in new gun-lift battery. Obturating friction primers. Fired into sand butt on beach. The cartridge bags were not cut. Cartridges of all weights were made approximately the same lengths. Firing conducted by Lieut. M. F. Harmon, First Artillery.
D, 52,000 H, 53,500	5	8	5	8		Check valve did not act, and gun returned to firing position. In running the gun into battery the breechblock was left open. The console caught on the side of the carriage and broke off the latch which holds breech mechanism open. The failure of the first primer to ignite the charge was probably due to the charge being forced too far into the chamber. The fact that it was forced in about 3 inches farther than desirable was noted when the piece was being loaded. Second bolt to the right from loading platform in roller apron broken; shot came out of butt. 28,000 coppers of 1890 in gauge D, and 32,000 coppers of 1892 in gauge H.	
D, 21,246 H, 21,523	5	8	0	0		14,000 coppers of 1892 in gauge D; 18,000 coppers of 1892 in gauge H. Shot came out of butt; fell in water.	
D, 32,540 H, 34,300	5	9	5	9		Coppers same as previous round. Check valve did not act, and gun returned to firing position.	

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing,

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Powder. Number of prisms.	Projectile. Kind.	Projectile. Weight.	Shot marked.	Travel of shot in bore.	Depression.	Instrumental velocity, 275 feet from muzzle.
1894.			*Pounds.*			*Pounds.*		*Inches.*	° '	*Feet.*
Jan. 20	101	Du Pont's brown prismatic, W. Q.	135 150 150 435	1, 388+7 1, 551 1, 551	Solid shot, lot 344.	996	....	330	2 47	1, 850 1, 844
Jan. 20	102		150 150 150 450	1, 551 1, 551 1, 544+7		1, 000	....	330	2 48½	1, 898 1, 896
[Object of firing, to test										
1894.										
Mar. 7	103	Du Pont's brown prismatic, W. Q.	143 150 150 443	1, 499 1, 572 1, 554+7	Solid shot, rebanded.	1, 002	....	330	2 40	....
									Elevation. ° '	
Mar. 7	104		150 143 150 443	1, 574 1, 497 1, 550+7		1, 001½	....	329	3 0	....
Mar. 7	105		143 150 150 443	1, 503 1, 568 1, 551+7		1, 003	....	329	5 0	....
Mar. 7	106		143 150 150 443	1, 483 1, 558 1, 551+7		1, 001	....	329	10 0	....
Mar. 7	107		143 150 150 443	1, 487 1, 568 1, 552+7		1, 002	....	329	19 39	....

Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

to prove powder.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In.*	*Ft.*	*In.*			
D, 35,400 H, 34,400	5	10	5	10	Wind calm; barometer, 30.67; thermometer, 36°; humidity, 48.	Check valve did not act, and gun returned to firing position. Shot came out of butt. 28,000 coppers, gauge D; 32,000 coppers, gauge H.	
D, 39,367 H, 38,683	5	10	5	10		Check valve did not act, and gun returned to firing position.	

new hydraulic gun lift.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
D, 45,911 H, 49,275	5	9	....		Wind from rear, 8 miles an hour; barometer, 30.11; thermometer, 64°; humidity, 22.	Fired into sand butt on beach. Velocity computed for this round from proof of powder, 1,878.5.	Gun mounted on Schneider carriage on lift in new gun-lift battery. Obturating friction primers. Rounds 104, 105, 106, and 107 fired to sea. Firing conducted by Lieut. M. F. Harmon, First Artillery.
D, 36,333 H, 37,866	6	0	6	0		Gun run in battery. Check valve tapped before firing.	
D, 35,862 H, 36,883	6	0	6	0		Gun run in battery. Check valve tapped before firing. The hydraulic rammer did not work properly.	
D, 34,243 H, 34,473	5	9	....			The hydraulic rammer did not work properly. Check valve tapped to its seat, and pump worked a couple of strokes before firing to guaranty that the valve was seated.	
D, 34,330 H, 35,693	5	8½	....			Powder rammed in by hand. Hydraulic rammer not working. Check valve tapped to its seat and pump worked a couple of strokes before firing to guaranty that the valve was seated. Time of flight, 34½ seconds. 19° 39′ is the maximum elevation obtainable on this carriage.	

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing,

Date.	No. of fire.	Powder.				Projectile.		Shot marked.	Travel of shot in bore.	Depression.		Instrumental velocity, 275 feet from muzzle.
		Kind.	Weight.		Number of prisms.	Kind.	Weight.					
1894.			*Lbs.*	*Oz.*			*Pounds.*		*Inches.*	°	'	*Feet.*
Apr. 10	108	Du Pont's brown prismatic, W. U., lot 2.	117	0	1,229	Solid shot, lot 344.	1,001	2	330.2	2	45	1,658 Lost.
			91	0	952							
			117	0	1,223+7							
			325	0								
Apr. 10	109		142	0	1,481+7		1,001	3	330.2	3	0	1,755 Lost.
			142	0	1,485							
			66	0	689							
			350	0								
Apr. 10	110		42	4	445		1,001	Not marked.	330.2	3	5	1,714 Lost.
			150	0	1,569							
			150	0	1,562+7							
			342	4								
Apr. 10	111		175	0	1,844		1,000	4	330.2	3	7	1,771 Lost.
			175	0	1,846							
				6	Rifle powder igniter.							
			350	6								

Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

to prove powder.]

Pressure per square inch of bore.	Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In*	*Ft.*	*In.*			
U, 29,564 P, 32,480	5	6	0	6	Wind from right, 90°, 22 miles an hour; barometer, 30.18; thermometer, 40°; humidity, 68.	24,000 coppers 1890 in gauge U and 32,000 coppers of 1892 in gauge P. Shot came out of the butt.	Gun mounted on Schneider carriage on lift in new gun-lift battery. Obturating friction primers. Fired into sand butt. 32,000 coppers of 1892 in rounds 109 to 111, inclusive. Firing conducted by Lieut. M. F. Harmon, First Artillery.
U, 39,545 P, 37,850	6	0	6	0		Shot came out of butt	
H, 32,939 P, 33,300	5	7	....			Shot came out of butt	
H, 67,200 P, 62,600	6	0	6	0		Both shot and powder rammed by hand, hydraulic rammer not working. The axial column of prisms was omitted in this charge and an igniter of rifle powder was substituted. Each section of the cartridge had its own igniter, which was made long enough to pass clear through and project from both ends. The spindle was broken by this round just in front of the spindle nut, and the rear portion, with both nuts still on it, was thrown some distance to the rear. The spindle was cracked radially. The fracture of the spindle shows good steel.	

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons), Watervliet

[Object of firing, to test gun

Date.	No. of fire.	Powder.					Projectile.		Deflection points, left.	Elevation.			Pressure per square inch of bore.
		Kind.	Marks on powder boxes.	Weight.		Number of prisms.	Kind.	Weight.					
1894.				*Lbs.*	*Oz.*			*Pounds.*			°	′	*Pounds.*
Dec. 6	112	Du Pont's brown prismatic, W. Z.	....	120 90 90	0 0 0	1,239 930 929	Solid shot, lot 373.	1,000	....		10	0	B, 17,241 V, 16,759
				300	0								
Dec. 6	113		....	154 154 149	12 12 12 12	1,596 1,601 1,543 Igniter.		1,000	6	Scott sight. Quadrant..	2 2	12 19	J, 34,446 O, 33,818
				460	0								
Dec. 6	114		....	154 149 162	12 12 12 12	1,595 1,543 1,683 Igniter.		1,000	6	Scott sight. Quadrant..	2 2	10 17	B, 33,244 V, 32,709
				468	0								
Dec. 15	115	Du Pont's brown prismatic. W. Z., lot 2.	C 11 B 1 A 17	153 152 152	12 12 12 12	1,602 1,592 1,595 Igniter.		1,000	....		10	0	V, 37,164 U, 36,644
				460	0								

Arsenal, at Sandy Hook Proving Ground, from December 6 to December 19, 1894.

for accuracy at 3,000 yards.]

Recoil.		Counter recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Ft.	*In.*	*Ft.*	*In.*			
5	8½	0	0	Wind from left and rear, 15 miles an hour; barometer, 30.19; thermometer, 48°; humidity, 66.	Fired to sea, to observe working of carriage. Gun hung fire.	Gun mounted on Schneider carriage on the south lift of gun-lift battery. Obturating friction primers. Fired at 3,000-yard target. When the gun is down in the position for loading the trunnions are below the axis of the hydraulic rammer prolonged, so that in order to load to the best advantage the muzzle must be depressed below the inclination of the rammer; this gives to the bottom of the bore, shot hoist, and intermediate tray (which should all form a continuous surface) 3 different inclinations. Therefore when the rammer is moved forward in loading its head rides up and down on the base of the projectile, or the section of the cartridge, grinding and breaking the rear prisms and crushing the igniter on the base. The intermediate tray is circular in cross section, while the bed for the powder on the hoist is of a broad V-shape; and the edges of the former project above the latter so that when a section of the cartridge is pushed forward one of the columns of prisms generally comes up against the end of the tray, crushing and breaking the grains and tearing the bag. After loading the 114th round many fragments of grains and considerable pulverized powder were left over the shot hoist and intermediate tray.
5	11	5	11		Aimed at the center of top of target. In this direction the muzzle of the gun is over the terreplein. The coping of the breast height wall from 3 to 6 inches deep and 23 feet in length was torn off by the blast. The check valve failed to act and the gun returned to battery. Valve taken out and examined; the spring was upset and the ribs of the valve apparently had bound; these were filed down and the valve and spring replaced, after which the pump worked to pump from battery. Struck target 4½ feet above, 6 inches left of center. Slight leakage of oil through stuffing box at right cylinder.	
5	11	5	11		Check valve failed again to operate and the gun returned to battery. The valve was taken out and the brass spring was replaced by a steel one. An iron sleeve was placed around it, limiting the rise of the valve to ¾ inch as against ⅞ inch before, to prevent the end of the valve spindle from striking and upsetting in its seat. Shot struck 4 feet right and 1 foot below center. 2 feet more of coping of breast height wall blown off.	
5	9	5	9	....	The base of each cartridge bag was cut, the igniter put inside, and the bag sewed over it. Pulverized powder was found on shot hoist after ramming the first cartridge. The elevation of the gun for loading to best advantage is about 4° 13′. The rammer has an inclination of 5° 25′. When the gun is elevated to 5° and the rammer run forward to the breech, the measurements from the rammer head to the inner circumference of the breech are 2¾ inches on top and 5¼ inches below. The shot pan is damaged by firing and needs repairs. The first primer failed. The old Scott sight was left on the gun and the F. A. rear (bar) sight was run up to 8° for this round. Nothing was injured by firing. Opposite each section of the cartridge were the manufacturers' marks on the boxes from which each was taken. The sections were put in the gun in the order given.	It is believed that with these arrangements the process of loading is attended with serious danger of igniting the charge unless the greatest care is exercised. When the Scott sight reads 0° and is aimed on the top of the target the quadrant reads +7′; horizontal error of mounting of sight seat 17′ right, approximately. There should be a small platform about 18 inches high on the racer near the front end of right chassis to stand on for sighting with the Scott sight, and a step fixed to racer near it, to step up from the floor of the gun lift. Firing suspended because the service pressure could not be obtained with this powder. Firing conducted by Lieut. F. P. Peck, Ordnance Department, in the presence of the testing board. Present: Maj. F. H. Phipps, Ordnance Department; Capt. F. Heath, Ordnance Department; Lieut. F. P. Peck, Ordnance Department. W. S. Peirce, Lieutenant, Ordnance Department, U. S. A.

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing, to test gun

Date.	No. of fire.	Powder.					Projectile.		Deflection points, left.	Elevation.			Pressure per square inch of bore.
		Kind.	Marks on powder boxes.	Weight.		Number of prisms.	Kind.	Weight.					
1894.				*Lbs.*	*Oz.*			*Pounds.*			°	′	*Pounds.*
Dec. 19	116	Du Pont's brown prismatic, W. Z., lot 2.	A 6 B 27 C 10	153 152 152 460	12 12 12 12 0	1,606 1,593 1,591 Igniter.	Solid shot, lot 373.	1,000	6	Sight .... Quadrant ...	2 2	10 17	J, 37,127 O, 37,667
Dec. 19	117		A 24 B 6 C 5	153 152 152 460	12 12 12 12 0	1,605 1,595 1,590 Igniter.		1,000	6	Sight .... Quadrant ...	2 2	4 11	J, 36,578 O, 35,859
Dec. 19	118		A 19 B 5 C 13	153 152 152 460	12 12 12 12 0	1,606 1,593 1,593 Igniter.		1,000	6	Sight .... Quadrant ...	2 2	6 13	J, 37,200 O, 37,617
Dec. 19	119		A 20 B 37 C 12	153 152 152 460	12 12 12 12 0	1,606 1,593 1,591 Igniter.		1,000	6	Sight .... Quadrant ...	2 2	6 13	U, 38,240 V, 38,455
Dec. 19	120		A 7 B 4 C 15	153 152 152 460	12 12 12 12 0	1,606 1,593 1,593 Igniter.		1,001	6	Sight .... Quadrant ...	2 2	6 13	J, 38,636 O, 38,380
Dec. 19	121		A 31 B 18 C 18	153 152 152 460	12 12 12 12 0	1,606 1,592 1,592 Igniter.		1,001	6	Sight .... Quadrant ...	2 2	6 13	U, 36,356 V, 37,018
Dec. 19	122		A 27 B 7 C 14	153 152 152 460	12 12 12 12 0	1,605 1,593 1,592 Igniter.		1,001	6	Sight .... Quadrant ...	2 2	6 13	J, 39,560 O, 38,000
Dec. 19	123		A 8 B 32 C 3	153 152 152 460	12 12 12 12 0	1,605 1,593 1,592 Igniter.		1,002	6	Sight .... Quadrant ...	2 2	6 13	U, 36,923 V, 36,756
Dec. 19	124		A 1 B 29 C 6	153 152 152 460	12 12 12 12 0	1,608 1,592 1,593 Igniter.		1,003	....		19	32½	J, 36,467 O, 36,222

Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

for accuracy at 3,000 yards.]

Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Ft. In.	*Ft. In.*			
5 11	......	Wind from right and rear, 35°, 6 miles an hour.	The by-pass valve opened and allowed the gun to return in battery. About 3 feet more of the coping of breast-height wall blown off. The shot missed the target (over). The valve was closed by striking it with a hammer, after which the pumps worked to pump from battery.	The shot pan has been repaired since last firing. Gun aimed at the center of the top of the target. In order to avoid the danger of crushing the rear prisms and the igniter, noted on Dec. 6, a wooden disk was placed at the base of each section of the cartridge so that the rammer would ride up and down on this instead of on the powder. It was removed from each section at the breech. The rammer does not start forward for several seconds after operating the lever. There was considerable leakage of water at the rear joint of rammer cylinder throughout the firing. There should be a railing at the sides of the floor of the gun lift when down to prevent accident from stepping off. This could stand on the concrete walls just below the level of the floor. The F. A. breech sight was set at 8° throughout the firing, and was not injured.
5 11	......		The by-pass valve acted as in previous round. More of the coping was torn off. Shot struck 6 feet below and 4½ feet right. The screws holding down the corner plates of the lift are coming loose.	
5 11	......		The by-pass valve acted as in round 116. The shot struck 6¼ feet above and 5 feet right.	
6 0	......	Wind from left and rear, 10°, 3 miles an hour.	The by-pass valve acted as in round 116. The shot struck 5 feet 8 inches above and 9 feet right.	
6 0	......	Wind from left, 90°, 4 miles an hour.	The by-pass valve was taken out and cleaned before this round, but failed to check the return to battery except during the last 2 feet. The shot struck 6 feet 8 inches above and 10 feet right.	
6 0	......		The by-pass valve acted as in round 116. The shot struck 5½ feet right of center.	
6 0	......	Wind from left and front, 45°, 5 miles an hour.	A wedge was driven in between the by-pass valve spindle and the cam shaft to hold the valve closed on firing. The shot struck 8 feet above and 7 feet 8 inches right.	
6 0	......		The wedge was again used, but came out on firing and the gun returned to battery. The shot struck 1½ feet below and 2½ feet right.	
6 0	......		The wedge was again used on the by-pass valve. There were ships behind the target and it was getting too dark to wait to continue the target, so the shot was fired to sea. When the gun had been elevated to the elevation given, the friction clamp became loose. After firing, the elevating gear was examined and it was found that the set nuts had been turned by elevating, thus relieving the pressure on the friction washers sufficiently to allow this to slip. The nuts were tightened and the gear cleaned. 1 bolt holding the inner part of the gear cover was found broken.	

No. of round.	From center of target.				From center of impact.			
	Vertical.		Horizontal.		Vertical.		Horizontal.	
	Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.
	Ft.	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*
118	6.5	...	5	...	2.277	.....	.....	1.612
119	5.67	...	9	...	1.447	.....	2.388	.....
120	6.67	...	10	...	2.447	.....	3.388	.....
121	0		5.5	...	.....	4.223	.....	1.112
122	8	...	7.67	...	3.777	.....	1.058	.....
123	....	1.5	2.5	...	.....	5.723	.....	4.112

	Feet.
Center of impact:	
Above	4.223
Right	6.612
Mean vertical deviation from center of impact	3.316
Mean horizontal deviation from center of impact	2.278
Mean deviation from center of impact	4.023

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons), Watervliet

[Object of firing, to test

Date.	No. of fire.	Powder.					Projectile.		Observed time of flight.	Travel of shot in bore.	Elevation.		Deflection points, left.
		Kind.	Marks on powder boxes.	Weight.		Number of prisms.	Kind.	Weight.					
1894.				*Lbs.*	*Oz.*			*Pounds.*	"	*Inches.*	°	'	
Dec. 26	125	Du Pont's brown prismatic, W. Z., lot 2.	A 21	153	12	1,607	Solid shot, lot 373.	1,001	....	....	10	0	11
			B 25	152	12	1,593							
			A 35 B 38	152	12	1,593							
					12	Igniter.							
				460	0								
Dec. 26	126		A 18	153	12	1,607		1,003	19⅜	....	10	0	11
			B 13	152	12	1,594							
			A 25 B 2	152	12	1,595							
					12	Igniter.							
				460	0								
Dec. 26	127		A 28	153	12	1,606		1,003	19⅜	....	10	0	11
			B 12	152	12	1,593							
			A 35 B 28	152	12	1,595							
					12	Igniter.							
				460	0								
Dec. 26	128		A 30	153	12	1,607		1,003	21	....	10	0	11
			B 21	152	12	1,595							
			A 34 B 14	152	12	1,593							
					12	Igniter.							
				460	0								
Dec. 26	129		A 26	153	12	1,606		1,004	19⅜	....	10	0	11
			B 19	152	12	1,593							
			A 25 B 2	152	12	1,594							
					12	Igniter.							
				460	0								
Dec. 26	130		A 29	153	12	1,605		1,004	27⅜	....	15	0	11
			B 31	152	12	1,593							
			A 34 B 14	152	12	1,595							
					12	Igniter.							
				460	0								
Dec. 26	131		A 32	153	12	1,606		1,002	28¼	....	15	0	11
			B 11	152	12	1,594							
			A 3 B 22	152	12	1,596							
					12	Igniter.							
				460	0								
Dec. 26	132		A 12	153	12	1,607		1,002	27⅜ 27⅛	....	15	0	11
			B 3	152	12	1,594							
			A 3 B 22	152	12	1,594							
					12	Igniter.							
				460	0								

Arsenal, at Sandy Hook Proving Ground, from December 26, 1894, to April 22, 1895.

gun for accuracy and range.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft. In.*			
U, 35,267 V, 34,077	6 0	Wind from left and front, 49°, 20 miles an hour; barometer, 30.46; thermometer, 33°; humidity, 90.	The hydraulic rammer failed to work after the projectile had been rammed. The head of the cylinder was removed and new packing put in about the piston, causing a delay of three-fourths hour. Range. Deviation to the right of line of fire.	Since the last firing the by-pass valve has been repaired by fixing a stud on the cam stop on the opposite side from the cam, which holds the valve closed on firing. 2 gallons of oil added to cylinder. Fired to sea. Direction given by Scott sight No. 626, aiming at the top of a post planted near the beach. Elevation given by quadrant. Line of fire slightly to the right of the Scotland lightship. The trunnions of the gun are — feet above mean low water. Scott sight No. 627 was placed on the gun before each round. It was not injured in the least by being left on the gun. The elevation of the gun platform (bottom surface of base ring) is 49.9 feet above mean low water. The exact height of the trunnions above this point has not been measured. It is about 9 feet 4 inches, making total height 59.2 feet.
J, 35,289 O, 36,711	6 0		Range. Deviation to the right of line of fire.	
U, 36,160 V, 35,222	6 0		Gasket at rear end of rammer cylinder partially blown out. Range. Deviation to the right of line of fire.	
J, 34,906 O, 35,418	6 0		Range. Deviation to the right of line of fire.	
U, 37,200 V, 36,267	6 0		Range. Deviation to the right of line of fire.	
J, 36,756 O, 35,378	6 0		Range. Deviation to the right of line of fire.	
U, 35,491 V, 35,906	6 0		Range. Deviation to the right of line of fire.	
J, 35,700 O, 34,733	6 0		After this round the hoop (C 10) had moved forward 0.0555 inch from the tube, but there was no noticeable separation in the joint between the C_1 hoop. Range. Deviation to the right of line of fire.	

Target at 10°.		Target at 15°.	
No. of round.	Range.	No. of round.	Range.
	Yards.		*Yards.*
125	9,106.16	130	11,819.5
126	9,169.03	131	11,731.1
127	9,184.40	132	11,794.0
128	9,080.58	133	11,714.0
129	9,114.15	134	11,714.0

	Yards.
Target at 10°:	
Mean range	9,130.86
Greatest range	9,184.40
Least range	9,106.16
Dispersion in range	78.24
Target at 15°:	
Mean range	11,754.64
Greatest range	11,819.5
Least range	11,714.0
Dispersion in range	105.5

Firing conducted by Lieut. F. P. Peck, Ordnance Department.

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing, to test

Date.	No. of fire.	Powder.					Projectile.		Observed time of flight.	Travel of shot in bore.	Elevation.		Deflection point-left.
		Kind.	Marks on powder boxes.	Weight.		Number of prisms.	Kind.	Weight.					
1894.				*Lbs.*	*Oz.*			*Pounds.*	"	*Inches.*	°	'	
Dec. 26	133	Du Pont's brown prismatic, W. Z., lot 2.	A 11 B 20 A 13} B 9}	153 152 152 460	12 12 12 12 0	1,607 1,594 1,594 Igniter.	Solid shot, lot 873.	1,002	28 28¼	....	15	0	11
Dec. 26	134		A 4 B 10 A 13} B 9}	153 152 152 460	12 12 12 12 0	1,608 1,594 1,594 Igniter.		1,002	30 29½	....	15	0	11
1895. Mar. 27	135		....	153 152 163 471	12 12 12 12 0	1,606 1,593 1,698 Igniter.	Solid shot, lot 344.	997	....	330.1	5	0	....
Mar. 27	136		....	164 152 152 471	12 12 12 12 0	1,712 1,593 1,593 Igniter.	Solid shot, lot 373.	998	....	330.1	5	0	....
Mar. 27	137		....	173 152 152 480	12 12 12 12 0	1,808 1,593 1,593 Igniter.		998	....	330.1	10	0	......
Apr. 11	138		....	164 152 152 471	12 12 12 12 0	1,711 1,593 1,592 Igniter.		1,000½	....	330.1	10	0	....
Apr. 22	139	Du Pont's brown prismatic, W. Z., lot 4.	....	154 154 144 455	12 12 12 12 0	1,585 1,585 1,481 Igniter.	Solid shot, lot 344.	1,001	....	330.1	19	47	....

Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

gun for accuracy and range.]

Pressure per square inch of bore.	Recoil.		Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In.*			
U, 35,977 V, 33,855	6	0	Wind from left and front, 29°; 20 miles an hour; barometer, 30.46; thermometer, 33°; humidity, 90.	Range. Deviation to the right of line of fire.	
J, 36,708 O, 36,060	6	0		Range. Deviation to the right of line of fire.	
B, 34,145 E, 33,631	5	10	....	....	The locking device for rotating handle does not work.
B, 33,400 E, 33,160	5	10	....	....	
B, 33,160 E, 32,833	5	11	....	The translating roller badly burred; burrs removed.	
O, 33,982 V, 33,433	6	0	....	....	
M, 37,200 N, 36,333	6	0	....	Firing suspended on account of haze.	

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons), Watervliet

[Object of firing,

Date.	No. of fire.	Powder. Kind.		Powder. Weight. Lbs.	Powder. Weight. Oz.	Powder. Number of prisms.	Projectile. Kind.	Projectile. Weight.	Observed time of flight.	Travel of shot in bore.	Depression. °	Depression. ′	Instrumental velocity, 275 feet from muzzle.
1895.				*Lbs.*	*Oz.*			*Pounds.*	″	*Inches.*	°	′	*Feet.*
June 12	140	Du Pont's brown prismatic, W. Z., lot 4.	H.	151	12	1,548	Solid shot, lot 373.	998	....	330.5	2	49	1,989
				151	12	1,548							1,988
				150	12	1,539							
					12	Igniter.							
				455	0								
June 12	141		E.	147	12	1,525		1,000½	....	330.5	2	55	2,053
				151	12	1,564							2,083
				149	12	1,544							
					12	Igniter.							
				450	0								
June 12	142		D.	154	12	1,595		1,000½	....	330.5	2	45	1,885
				152	12	1,566							1,892
				151	12	1,577							
					12	Igniter.							
				460	0								
June 14	143		B.	139	12	1,432		1,003	....	330.5	2	45	1,956
				139	12	1,432							1,971
				139	12	1,432							
					12	Igniter.							
				420	0								
June 14	144		C.	156	12	1,604		1,001	....	330.5	2	48	2,056
				156	12	1,603							2,065
				155	12	1,594							
					12	Igniter.							
				470	0								
June 14	145		A.	139	12	1,416		1,002	....	330.5	2	45	1,886
				139	12	1,418							1,887
				119	12	1,284							
					12	Igniter.							
				400	0								
June 14	146		F.	137	12	1,406		1,001	....	330.2	2	50	1,965
				151	12	1,554							1,971
				149	12	1,534							
					12	Igniter.							
				440	0								
June 14	147		P. 6.	141	12	1,460		1,001	....	330.5	2	50	1,033
				141	12	1,460							1,036
				135	12	1,396							
					12	Igniter.							
				420	0								
June 14	148		F.	147	12	1,514		1,001	....	330.6	2	50	1,966
				151	12	1,555							1,984
				149	12	1,535							
					12	Igniter.							
				450	0								

Arsenal, at Sandy Hook Proving Ground, from June 12, 1895, to April 22, 1896.

to prove powder.]

Pressure per square inch of bore.	Recoil.		Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In.*	*Inches.*			
C, 28,490 G, 35,783	6	0	....	Wind from rear, 10 miles an hour; barometer, 29.94; thermometer, 70°; humidity, 86.	24,000 coppers of 1890	Gun mounted on Schneider carriage on the north lift of gun-lift battery. Obturating friction primers. Fired into sand butt on the beach about 700 feet in front of gun. 32,000 coppers of 1890. The gun elevates and depresses with great difficulty, requiring 7 men for the operation. This was not the case when the gun was mounted on this carriage before, and the cause may be that the trunnion beds and rimbases were burred in the operation of mounting the gun. After firing rounds 145 and 146 the primer was removed with great difficulty. The friction elevating gear does not work well. In elevating the gun the friction is sufficient between the plates and nut to unscrew the nut, therefore diminishing the friction necessary to accomplish the elevation.
G, 39,156 N, 42,311	6	1	....		The projectile came out of butt and ricochetted to the left after striking the water.	
G, 33,877 N, 33,483	5	9	....		The projectile struck short and ricochetted to sea.	
G, 37,700 N, 38,000	5	10⅛	....	Wind from right and rear, 30°, 16 miles an hour; barometer, 29.96; thermometer, 85°; humidity, 53.	....	
G, 42,622 N, 42,836	5	11¼	....		....	
G, 36,289 N, 36,100	5	11¼	....		....	
G, 38,455 N, 38,677	5	11¼	....		....	
Less than 32,000	5	7	....		The projectile struck about 50 yards short and ricochetted to sea. Only about one-half the charge consumed. This powder is entirely too slow.	
G, 39,800 N, 41,311	5	11¾	....		....	

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing,

Date.	No. of fire.	Powder.				Projectile.		Observed time of flight.	Travel of shot in bore.	Elevation.		Instrumental velocity, 275 feet from muzzle.
		Kind.	Weight.		Number of prisms.	Kind.	Weight.					
1895.			*Lbs.*	*Oz.*			*Pounds.*	"	*Inches.*	°	'	*Feet.*
June 15	149	Du Pont's brown prismatic, W. Z., lot 4.	159 159 164	12 12 12 12	1,636 1,636 1,686 Igniter.	Solid shot, lot 373.	1,000	....	330.4	−2	44	1,913 1,922
			485	0								
June 15	150		159 159 159	12 12 12 12	1,644 1,640 1,612 Igniter.		1,002	....	330.4	−2	40	1,320 1,324 200+$\frac{152}{2}$
			480	0								
June 15	151	A B C D E F	139 111 45 18 86 33	0 0 0 8 0 8 12	1,463 1,467 1,477		1,000	....	330.3	10	0	....
			433	12								
July 9	152	Du Pont's brown prismatic, W. Z., 5.	146 146 145	12 12 12 12	1,475 1,476 1,464 Igniter.		1,000	....	330.2	−2	41	1,892 1,895
			440	0								
July 10	153		153 152 152	12 12 12 12	1,544 1,533 1,533 Igniter.		1,000	....	330.4	−2	42	1,931 1,942
			460	0								
July 10	154		175 173 149	12 12 12 12	1,840 1,820 1,568 Igniter.		1,000	....	330.4	9	0	....
			500	0								

Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

to prove powder.]

Pressure per square inch of bore.	Recoil.		Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft.*	*In.*	*Inches.*			
G, 34,446 N, 35,500	6	0	....	....	This powder was evidently too slow, as a number of unburnt grains were found on the parapet and in the gun after firing. The projectile came out of the butt and struck on the beach near the water line.	There was apparently quite a movement of the hoops to the front over the tube. At the end of the firing the first hoop projected over the tube nearly $\frac{1}{16}$ inch. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department.
G, less than 18,000 N, less than 32,000	6	0	....	....	This powder was too slow and a great quantity of unburnt grains was thrown out of the muzzle.	
G, 38,127 N, 36,939	6	0	....	....	....	
J, 31,400 K, 32,027	6	1	0	....	....	Firing conducted by Lieut. W. S. Peirce, Ordnance Department.
J, 33,737 K, 33,677	6	1	0	Barometer, 29.90; thermometer, 87°; humidity, 67.	....	
O, 39,620 P, 39,480	6	0	0		....	

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing, test of gun

Date.	No. of fire.	Powder. Kind.	Powder. Weight. Lbs	Powder. Weight. Oz.	Powder. Number of prisms.	Projectile. Kind.	Projectile. Weight. Pounds.	Observed time of flight. "	Travel of shot in bore. Inches.	Elevation. °	Elevation. '	Instrumental velocity.
1895. Aug. 7	155	Du Pont's brown prismatic, W. Z., 5.	172 172 138 485	12 12 12 12 0	1,808 1,805 1,451 Igniter.	Solid shot, lot 650.	1,006			10	0	
Aug. 7	156		172 172 138 485	12 12 12 12 0	1,808 1,808 1,451 Igniter.	Solid shot, lot 373.	1,004			10	0	
Aug. 7	157		172 172 138 485	12 12 12 12 0	1,808 1,808 1,451 Igniter.		1,000			10	0	
Aug. 7	158		172 172 138 485	12 12 12 12 0	1,808 1,808 1,451 Igniter.		998			10	0	
Aug. 7	159		172 172 138 485	12 12 12 12 0	1,808 1,808 1,451 Igniter.		1,003			10	0	

[Object of firing.

Date.	No. of fire.	Powder. Kind.	Powder. Weight. Lbs	Powder. Weight. Oz.	Powder. Number of prisms.	Projectile. Kind.	Projectile. Weight.	Observed time of flight.	Travel of shot in bore.	Elevation. °	Elevation. '	Instrumental velocity.
1895. Oct. 7	160	Du Pont's brown prismatic, W. Z., lot 5. B	172 172 138 485	12 12 12 12 0	1,804 1,808 1,433 Igniter.	Solid shot, lot 650.	1,003		330.4	10	0	
Oct. 7	161	B	172 172 138 485	12 12 12 12 0	1,805 1,801 1,448 Igniter.		1,005		330.5	10	0	
Oct. 9	162	B	172 172 138 485	12 12 12 12 0	1,809 1,810 1,451 Igniter.		1,004		330.5	10	0	
Oct. 9	163	C	172 172 138 485	12 12 12 12 0	1,808 1,808 1,451 Igniter.		1,004		330.5	10	0	

Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

lift battery for rapidity.]

Pressure per square inch of bore.	Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Ft. In.*	*Inches.*			
....	......	......	....	....	Gun mounted on Schneider carriage on north lift of gun-lift battery. Obturating friction primers. Fired to sea. During this firing the rammer stuck several times and had to be started by blows from a block of wood. At other times it worked slowly. H. M. S. Total time to fire 10 shots .... 1 25 30 Deductions .... 0 46 21 Actual time of firing .... 0 39 06 Time lost because rammer would not work ...... 0 10 47 Time lost because carriage would not run into battery .... 0 1 20 Time charged to gun lift: Loss in traversing .... 0 0 37 Firing commenced .. 4 41 30 Firing ended .... 6 07 00 Firing conducted by Lieut. W. S. Peirce, Ordnance Department.
....	......	......	....	....	
....	......	......	....	....	
....	......	......	....	....	
....	......	......	....	....	

test of gun.]

J, 38,444 P, 35,860	6 2	1	....	Rear head of hydraulic rammer leaking.	
J, 35,333 P, 36,444	6 2	1	....	....	
I, 38,880 P, 39,320	6 0	0	Wind from rear and left, 65°, 19 miles an hour; barometer, 30.20; thermometer, 46°; humidity, 51.	....	
O, 38,980 K, 39,120	6 1	......		The blast from this round loosened the plate covers of carriage on south lift and broke cover of spiral stairs.	

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing,

Date.	No. of fire.	Powder.				Projectile.		Observed time of flight.	Travel of shot in bore.	Elevation.		Instrumental velocity.
		Kind.	Weight.		Number of prisms.	Kind.	Weight.					
1895.			*Lbs.*	*Oz.*			*Pounds.*	"	*Inches.*	°	'	
Oct. 9	164	Du Pont's brown prismatic, W. Z., lot 5. C	172 172 138 485	12 12 12 12 0	1,810 1,811 1,451 Igniter.	Solid shot, lot 650.	1,002	....	330.6	10	0	....
Oct. 9	165	C	172 172 128 475	12 12 12 12 0	1,810 1,811 1,346 Igniter.		1,004	....	330.6	10	0	....
Oct. 9	166	C	162 172 138 475	12 12 12 12 0	1,705 1,808 1,452 Igniter.		1,003	20¼	330.5	10	0	....
Oct. 9	167	C	157 172 138 470	12 12 12 12 0	1,649 1,809 1,451 Igniter.		1,004	....	330.6	10	0	....
Oct. 9	168	C	172 138 157 470	12 12 12 12 0	1,810 1,455 1,652 Igniter.	Solid shot, lot 373.	1,002	20	330.5	10	0	....
Oct. 9	169	C	172 138 157 470	12 12 12 12 0	1,809 1,451 1,656 Igniter.		1,003	20	330.7	10	0	....
Oct. 9	170	C	172 138 157 470	12 12 12 12 0	1,810 1,451 1,654 Igniter.		1,003	30	330.5	15	0	....
Oct. 9	171	C	172 138 157 470	12 12 12 12 0	1,809 1,451 1,653 Igniter.		1,006	30	330.5	15	0	....
Oct. 9	172	C	172 138 157 470	12 12 12 12 0	1,810 1,451 1,653 Igniter.		1,004	29¾	330.5	15	0	....
Oct. 9	173	C	172 138 157 470	12 12 12 12 0	1,811 1,455 1,655 Igniter.	Solid shot, lot 650.	1,005	30	330.4	15	0	....

Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

test of gun.]

Pressure per square inch of bore.	Recoil.		Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.			General remarks.
Pounds.	*Ft.*	*In.*	*Inches.*					
I, 39,080 P, 30,964	6	1	....	Wind from rear and left, 65°, 19 miles an hour; barometer, 30.20; thermometer, 46°; humidity, 51.	Slight leak around cylinder head. Bolts tightened.			Gun mounted on Schneider carriage on north lift of new gun-lift battery. Obturating friction primers. Escape of gas around primer at nearly every round. Catch of rotating handle does not work well. Threads in one of the pressure gauge seats are burred so badly as to cause great difficulty to remove the gauge. This was repaired before the firing of Oct. 9, 1895. A new gasket put in rear head of the rammer after the firing of Oct. 7.
O, 39,280 K, 38,080	6	1	....		....			
I, 39,680 P, 39,380	6	1	....		....			
O, 38,044 K, 37,578	6	0	....		Packing in the rear end of rammer blown out; replaced in 4 minutes and 30 seconds.			
I, 38,111 P, 38,111	6	1	0		....			
K, 37,756 O, 38,111	6	1	0		....			
I, 36,960 P, 36,133	6	1	0		....			
O, 38,756 K, 38,000	6	1	0		....			
I, 35,660 P, 38,044	6	1	0		....			
					Elevation.	Range.	Range.	
					° ′	*Yards.*	*Miles.*	
O, 37,467 K, 36,289	6	1	0		15 0	12,519	7.1132	

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing.

Date	No. of fire.	Powder.					Projectile.		Observed time of flight.	Travel of shot in bore.	Elevation.		Instrumental velocity.
		Kind.		Weight.		Number of prisms.	Kind.	Weight.					
1895.				*Lbs.*	*Oz.*			*Pounds.*	"	*Inches.*	°	'	
Oct. 9	174	Du Pont's brown prismatic, W. Z., lot 5.	D	172	12	1,808	Solid shot, lot 650.	1,003	29¾	330.4	15	0	....
				138	12	1,402							
				157	12	1,653							
					12	Igniter.							
				470	0								
Oct. 9	175		D	172	12	1,808		1,002	29½	330.35	15	0	....
				138	12	1,451							
				157	12	1,652							
					12	Igniter.							
				470	0								
Oct. 9	176		D	172	12	1,808		1,004	29¾	330.8	15	0	....
				138	12	1,451							
				157	12	1,652							
					12	Igniter.							
				470	0								
Oct. 9	177		D	172	12	1,808		1,003	29¾	330.4	15	0	....
				138	12	1,451							
				157	12	1,652							
					12	Igniter.							
				470	0								
Oct. 10	178		D	172	12	1,808		1,004	....	....	19	50	....
				138	12	1,451							
				157	12	1,652							
					12	Igniter.							
				470	0								
Oct. 10	179		D	172	12	1,808		1,004	39	....	19	50	....
				138	12	1,451							
				157	12	1,652							
					12	Igniter.							
				470	0								
Oct. 10	180		D	172	12	1,808		1,003	39¼	....	19	50	....
				138	12	1,451							
				157	12	1,653							
					12	Igniter.							
				470	0								
Oct. 10	181		D	172	12	1,808		1,003	....	....	19	50	....
				138	12	1,450							
				157	12	1,353							
					12	Igniter.							
				470	0								
Oct. 10	182		D	172	12	1,808		1,002	....	....	19	50	....
				138	12	1,452							
				157	12	1,654							
					12	Igniter.							
				470	0								
Nov. 23	183	W. Z., lot 6, A.		153	12	1,601		1,006	....	330.6	10	0	....
				153	12	1,602							
				151	12	1,581							
					12	Igniter.							
				460	0								

Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

test of gun.]

Pressure per square inch of bore.	Recoil.		Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.				General remarks.
					Elevation.		Range.	Range.	
Pounds.	*Ft.*	*In.*			°	′	*Yards.*	*Miles.*	
I, 37,960 P, 39,280	6	1	......	Wind from rear and left, 65°, 19 miles an hour; barometer, 30.20; thermometer, 46°; humidity, 51.	15	0	12,527.5	7.1179	15° elevation: Yards. Average range. 12,489.75 Greatest range. 12,527.5 Least range.... 12,379.2 Dispersion in range....... 148.3 19° 50′ elevation: Average range. 14,553.83 Greatest range. 14,791.4 Least range.... 14,434.5 Dispersion in range....... 356.9 Pressures taken and firing conducted by Lieut. W. S. Peirce, Ordnance Department, assistant proof officer.
O, 35,680 K, 36,800	......		......		15	0	12,379.2	7.0336	
I, 34,489 P, 38,422	6	1	......		15	0	12,514.2	7.1047	
O, 39,760 K, 38,578	6	1	......		......		......	......	
O, 36,920 K, 36,356	6	0	......	Wind from right and rear, 6 miles an hour; barometer, 30.20; thermometer, 55°; humidity, 48.	19	50	14,434.5	8.1956	
I, 38,489 P, 38,778	6	0	......		19	50	14,435.6	8.2019	
O, 39,720 K, 40,640	6	0	......		19	50	14,791.4	8.4041	
I, 39,420 P, 40,378	6	0	......		......				
O, 39,260 K, 39,640	6	0	......		Primer failed to ignite charge..				
O, 38,840 P, 38,840	6	0	......	....	32,000 coppers of 1895				Gun mounted on Schneider carriage on north lift in new gun-lift battery. Fired to sea. Firing conducted by Lieut. W. S. Peirce, Ordnance Department, in the presence of Cols. J. M. Wilson and G. L. Gillespie, Engineer Corps.

Record of firing with 12-inch B. L. rifle (*steel*), *type, No. 1* (*52* **tons**),

[Object of firing,

Date.	No. of fire.	Powder.				Projectile.		Observed time of flight.	Travel of shot in bore.	Elevation.	Instrumental velocity.
		Kind.	Weight.		Number of prisms.	Kind.	Weight.				
1896.			*Lbs.*	*Oz.*			*Pounds.*	"	*Inches.*	°	
Apr. 20	184	Du Pont's brown prismatic, W. Z., lot 6.	160 160 137 460	12 12 12 12 0	1,675 1,674 1,433 Igniter.	Solid shot, lot 690.	1,009	....	330.2	10	....
Apr. 20	185		160 160 137 460	12 12 12 12 0	1,669 1,669 1,430 Igniter.		1,003	19	330.2	10	....
Apr. 20	186		160 160 137 460	12 12 12 12 0	1,670 1,670 1,431 Igniter.		1,003	19	330.2	10	....
Apr. 20	187		160 160 137 460	12 12 12 12 0	1,670 1,670 1,430 Igniter.		1,002	....	329.9	10	....
Apr. 20	188		160 160 137 460	12 12 12 12 0	1,670 1,670 1,430 Igniter.		1,004	19	330	10	....
Apr. 20	189		160 160 137 460	12 12 12 12 0	1,671 1,670 1,431 Igniter.		1,003	19	329.9	10	....

Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

to obtain range.]

Pressure per square inch of bore.	Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.						General remarks.
				TARGET 10°.						
				Range.	Deviation, right.	From center of impact.				
						Longitudinal.		Lateral.		
						+	—	Right.	Left.	
Pounds.	*Feet.*	*Feet.*		*Yards.*	*Yds.*	*Yds.*	*Yds.*	*Yds.*	*Yds.*	
J, 38,385 K, 37,733	4	4	Wind from front and right, 55°, 15 miles an hour; barometer, 30.17; thermometer, 74°; humidity, 40.	.....						Gun mounted on 12-inch barbette carriage. Obturating friction primers. Powder put up Jan. 28, 1896. Scott sight No. 627 used. The gun was washed out and examined after each round. 32,000 coppers of 1890. Yards. Greatest range...... 9,410 Least range......... 9,257 Dispersion in range 153 Greatest deviation.. 18 Least deviation..... 10 Lateral dispersion 8 Mean range.......... 9,329.4 Mean deviation..... 13.8 Mean longitudinal deviation from center of impact..... 54.48 Mean lateral deviation from center of impact............ 2.56
J, 34,111 K, 35,400	4	4		9,257	12	.....	72.4	.....	1.8	
A, 35,600 X, 35,880	4	4		9,270	18	.....	59.4	4.2	.....	
J, 36,900 K, less than 32,000	4	4		9,410	16	.....	4.4	2.2	.....	
A, 35,860 X, 36,067	4	4		9,325	10	80.6	.....	.....	3.8	
P, 36,133 J, 32,160	4	4		9,385	13	55.6	.....	.....	.8	

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing, to determine velocities and

Date.	No. of fire.	Powder.				Projectile.		Observed time of flight.	Travel of shot in bore.	Elevation.	Instrumental velocity. 175 feet from muzzle.
		Kind.	Weight.		Number of prisms.	Kind.	Weight.				
1896.			*Lbs.*	*Oz.*			*Pounds.*	"	*Inches.*	′	*Feet.*
Apr. 22	190	Du Pont's brown prismatic, W. Z., lot 6.	160	12	1,670	Service band, lot 690.	1,002	....	329.9	10	1,943 1,943
			160	12	1,670						
			137	12	1,431						
				12	Igniter.						
			460	0							
Apr. 22	191		160	12	1,670	Large band, lot 709.	1,002	....	331.3	9½	1,966 1,966
			160	12	1,670						
			137	12	1,431						
				12	Igniter.						
			460	0							
Apr. 22	192		160	12	1,671	Service band, lot 690.	1,001½	....	330	10	1,962 1,962
			160	12	1,670						
			137	12	1,432						
				12	Igniter.						
			460	0							
Apr. 22	193		160	12	1,671	Large band, lot 709.	1,002	....	331.25	10	1,999 2,012 $225+\frac{110}{2}$
			160	12	1,671						
			137	12	1,434						
				12	Igniter.						
			460	0							

Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

pressures with charges put up at different dates.]

Pressure per square inch of bore.	Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Pounds.	*Feet.*	*Feet.*			
J, 34,422 P, 35,640	4	4	Wind from rear and left, 45°, 12 miles an hour; barometer, 30.01; thermometer 58°; humidity, 50.	Charge put up Jan. 29, 1896.....	Velocities taken by Lieut. George Montgomery, Ordnance Department.
A, 38,511 X, 38,400	4	4		Charge put up Apr. 2, 1896......	
A, 36,920 X, 37,067	4	4		Charge put up Apr. 22, 1896.....	
A, 39,945 X, 40,800	4	4		Charge put up Apr. 22, 1896.....	

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons), Watervliet

[Object of firing.

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Powder. Number of prisms.	Projectile. Kind.	Projectile. Weight.	Observed time of flight.	Travel of shot in bore.	Elevation.	Deflection points, right.	In azimuth.	Pressure per square inch of bore.
1896.			*Lbs. Oz.*			*Pounds.*	"	*Inches.*	°		'	*Pounds.*
Apr. 23	194	Du Pont's brown prismatic, W. Z., lot 6.	160 12 160 12 137 12 12 460 0	1,671 1,672 1,431 Igniter.	Solid shot, lot 709, large band.	1,002	28	331.2	15	....	....	K, 36, 880 J, 32, 000
Apr. 23	195		160 12 160 12 137 12 12 460 0	1,670 1,670 1,431 Igniter.		1,003	28½	331	15	....	....	A, 39, 900 X, 39, 440
Apr. 23	196		160 12 160 12 137 12 12 460 0	1,670 1,670 1,431 Igniter.		1,003	28	330.5	15	....	....	K, 37, 778 P, 39, 855
Apr. 23	197		160 12 160 12 137 12 12 460 0	1,671 1,671 1,430 Igniter.		1,003	27⅞	331	15	....	47½	A, 38, 222 X, 39, 520
Apr. 23	198		160 12 160 12 137 12 12 460 0	1,671 1,671 1,430 Igniter.		1,003	27⅛	331	15	....	46¼	K, 39, 540 P, 38, 411
Apr. 23	199		160 12 160 12 137 12 12 460 0	1,671 1,671 1,431 Igniter.		1,005	10⅞	331	5	....	....	A, 39, 040 X,
Apr. 23	200		160 12 160 12 137 12 12 460 0	1,671 1,670 1,430 Igniter.		1,005	10⅛	330.9	5	....	....	K, 36, 640 P, 35, 222
Apr. 23	201		160 12 160 12 137 12 12 460 0	1,671 1,671 1,430 Igniter.		1,005	10	330.9	5	....	....	A, 39, 460 X, 39, 540
Apr. 23	202		160 12 160 12 137 12 12 460 0	1,671 1,671 1,431 Igniter.		1,004	10⅛	330.95	5	....	....	A, 37, 089 X, 37, 756
Apr. 23	203		160 12 160 12 137 12 12 460 0	1,671 1,671 1,430 Igniter.		1,004	....	330.9	5	....	....	A, 38, 778 X, 38, 600

Arsenal, at Sandy Hook Proving Ground, from April 23 to June 2, 1896.

to obtain range.]

Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.						General remarks.
			TARGET 15°.						
			Range.	Deviation, right.	From center of impact.				
					Longitudinal.		Lateral.		
					+	−	Right.	Left.	
Feet.	*Feet.*		*Yards.*	*Yds.*	*Yds.*	*Yds.*	*Yds.*	*Yds.*	Aimed by Scott sight at iron telegraph pole in rear of traverse, and checked by indicator on azimuth circle. Elevation by quadrant. Gun washed out and examined after each round. The handle of the center shaft (useless) was put on the shot-hoist shaft, allowing 4 men to work. The quadrant used was the one which came with the 3.2-inch Hotchkiss gun. Powder put up Jan. 29, 1896. Some grains of powder, partially consumed, were found in the bore of the gun after discharge. Target 15°: Yards. Greatest range.. 12,330 Least range..... 12,200 Dispersion in range .... 130 Greatest deviation .... 89 Least deviation . 72 Lateral dispersion...... 17 Mean range..... 12,250.4 Mean deviation . 82.8 Mean longitudinal deviation from center of impact .... 47.68 Mean lateral deviation from center of impact........... 7.44 Target 5°: Greatest range.. 5,663 Least range..... 5,590 Dispersion in range .... 73 Greatest deviation .... 20 Least deviation. 7 Lateral dispersion...... 13 Mean range..... 5,625.2 Mean deviation . 11.8 Mean longitudinal deviation from center of impact .... 29.04 Mean lateral deviation from center of impact........... 3.36 Round 202: Slight escape of gas around primer. Round 203: The bracket on the left side which holds the long rod of sliding platform was broken off, and the bolts holding the front left brace broken. Both the long rods removed and the platform pushed back by hand before firing.
4	4	Wind from front. 11 miles an hour.	12,308	72	48.6	......	......	10.8	
4	4		12,200	75	......	59.4	......	7.8	
4	4	Wind from front, 16 miles an hour.	12,330	89	70.6	......	6.2	......	
4	4	Wind from front, 12 miles an hour.	12,250	89	......	9.4	6.2	......	
4	4		12,209	89	......	50.4	6.2	......	
			TARGET 5°.						
4	4	Wind from right, 90°, 12 miles an hour.	5,663	10	37.8	......	......	1.8	
4	4	Wind from right, 90°, 10 miles an hour.	5,623	10	......	2.2	......	1.8	
4	4	Wind from right, 90°, 9 miles an hour.	5,660	12	34.8	......	.2	......	
4	4	Wind from right and front, 25°, 9 miles an hour.	5,590	20	......	35.2	8.2	......	
4	4		5,590	7	......	35.2	......	4.8	

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing,

Date.	No. of fire.	Powder.				Projectile.		Observed time of flight.	Travel of shot in bore.	Elevation.	Deflection points, right.	In azimuth.	Pressure per square inch of bore.
		Kind.	Weight.		Number of prisms.	Kind.	Weight.						
1896.			*Lbs.*	*Oz.*			*Pounds.*	"	*Inches.*	°			*Pounds.*
Apr. 24	204	Du Pont's brown prismatic, W. Z., lot 6.	160 155 137 455	12 12 12 12 0	1,671 1,619 1,431 Igniter.	Solid shot, lot 709, large band.	1,002½		330.9	20			K, 38,689 P, 36,578
Apr. 24	205		160 160 132 455	12 12 12 12 0	1,670 1,670 1,379 Igniter.		1,002	35	330.9	20			A, 37,583 X, 37,600
Apr. 24	206		160 155 137 455	12 12 12 12 0	1,670 1,619 1,431 Igniter.		1,002	35¾	330.0	20			K, 36,660 P, 37,178
Apr. 24	207		160 160 132 455	12 12 12 12 0	1,671 1,671 1,319 Igniter.		1,002	36	330.9	20			A, 37,644 X, 38,044
Apr. 24	208		160 155 137 455	12 12 12 12 0	1,671 1,619 1,431 Igniter.		1,002	35	330.9	20			K, 35,556
Apr. 24	209		160 155 137 455	12 12 12 12 0	1,671 1,619 1,431 Igniter.		1,003	35	330.9	20			A, 38,400 X, 38,778
Apr. 24	210		160 160 137 460	12 12 12 12 0	1,672 1,671 1,430 Igniter.		1,004½	10	330.9	5			A, 35,089 X, 35,511
Apr. 24	211		160 160 137 460	12 12 12 12 0	1,671 1,671 1,431 Igniter.		1,004	10	330.9	5			K, 36,860 P, 34,489
Apr. 24	212		160 160 137 460	12 12 12 12 0	1,671 1,670 1,430 Igniter.		1,004	20¾	330.9	10			A, 36,556 X, 36,556
Apr. 24	213		160 160 137 460	12 12 12 12 0	1,671 1,671 1,431 Igniter.		1,004	27	330.9	15			K, 38,222 P, 34,720

Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

to obtain range.]

Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.						General remarks.
			TARGET 20°.						
			Range.	Deviation, right.	From center of impact.				
					Longitudinal.		Lateral.		
					+	−	Right.	Left.	
Feet.	*Feet.*		*Yards.*	*Yds.*	*Yds.*	*Yds.*	*Yds.*	*Yds.*	
4	4	....	....	.....	.....	.....	.....	.....	Target 20°: Greatest range.. 14,412 Least range..... 14,229 Dispersion in range .... 183 Greatest deviation .... 173 Least deviation. 152 Lateral dispersion...... 21 Mean range..... 14,331 Mean deviation . 1,624 Mean vertical deviation from center of impact........... 49.6 Mean lateral deviation from center of impact........... 7.92 Impressions taken after round 204. The arrangement for elevating and depressing the piece makes the operation very slow and difficult. There is too much lost motion in worm and worm-wheel for traversing accurately. Powder put up Apr. 2, 1896.
4	4	Wind from front and left, 30°, 20 miles an hour.	14,412	165	81	......	2.6	......	
4	4	Wind from front and left, 20 miles an hour.	14,309	158	......	22	......	9.4	
4	4	Wind from front, 0°, 20 miles an hour.	14,340	152	9	......	......	10.4	
4	4	Wind from front, 0°, 21 miles an hour.	14,229	169	......	102	6.6	......	
4	4		14,365	173	34	......	10.6	......	
4	4	....	Range, 5,430 yards; deviation, 32 yards. Powder put up Apr. 2, 1896.						
4	4	....	Range, 5,505 yards; deviation, 30 yards. Powder put up Apr. 2, 1896.						
4	4	....	Powder put up Jan. 29, 1896. Primer removed with difficulty.						
4	4	....	Range, 11,800 yards; deviation, 100 yards. Primer removed with great difficulty.						

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing, exhibition before the

Date.	No. of fire.	Powder.			Projectile.		Observed time of flight.	Travel of shot in bore.	Elevation.	Deflection points, right.	In azimuth.	Pressure per square inch of bore.
		Kind.	Weight.	Number of prisms.	Kind.	Weight.						
			Lbs. Oz.			*Pounds.*		*Inches.*	°			*Pounds.*
1896. Apr. 25	214	Du Pont's brown prismatic, W. Z., lot 6.	160 12 160 12 137 12 12 460 0	1,671 1,671 1,430 Igniter.	Solid shot, lot 709, large band.	1,003	....	330.9	10	.....	....	A, 35,578 X, 35,111

[Object of firing, to test

Date.	No. of fire.	Powder Kind.	Powder Weight.	Number of prisms.	Projectile Kind.	Projectile Weight.	Observed time of flight.	Travel of shot in bore.	Elevation.	Deflection points, right.	In azimuth.	Pressure per square inch of bore.
1896. May 6	215	Du Pont's brown prismatic, W. Z., lot 6.	115 0 115 0 111 0 114 0 455 0	1,185+7 1,187+7 1,146+7 1,178+7	Solid shot, lot 709, large band.	1,004	....	330.85	*Quad.* ° ′ 2 30 *Sight.* 2 30½	3	....	A, 36,740 X, 36,222
May 6	216		115 0 115 0 111 0 114 0 455 0	1,188+7 1,188+7 1,146+7 1,178+7		1,004	....	330.8	*Quad. Notch.* 2 29 *Sight.* 2 31 *Quad. F. A.* 2 32½	2	....	A, 37,133 X, 36,378
May 6	217		115 0 115 0 111 0 114 0 455 0	1,191+7 1,191+7 1,146+7 1,178+7		1,004	....	330.8	..do ..	2	....	A, 37,578 X, 36,556
May 6	218		115 0 115 0 111 0 114 0 455 0	1,188+7 1,188+7 1,146+7 1,177+7		1,004	....	330.8	..do ..	2	....	A, 38,667 X, 38,022
May 6	219		115 0 115 0 111 0 114 0 455 0	1,188+7 1,189+7 1,146+7 1,178+7		1,004	....	330.8	. do ..	2	....	J, 37,200 I, 37,089
May 6	220		115 0 115 0 111 0 114 0 455 0	1,188+7 1,188+7 1,146+7 1,178+7		1,003	....	330.8	..do ..	2	....	A, 37,756 X, 36,730

Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

Board of Ordnance and Fortification.]

Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
Feet.	*Feet.*			
4	0	....	....	Impressions taken after round 214, May 4, 1896.

accuracy at 3,000 yards.]

Recoil.	Counter recoil.	Wind, strength and direction.	TARGET. From center of target. Vertical. Above.	Below.	Horizontal. Right.	Left.	From center of impact. Vertical. Above.	Below.	Horizontal. Right.	Left.	General remarks.
6	6	Wind from front and left, 30°, 20 miles an hour; barometer, 30.55; thermometer, 55°; humidity, 76.	Pintle pin jumped up 2 inches. Elevating band moved ¼ inch.								Gun mounted on 12-inch proof carriage. Aimed at the upper left edge of target. A new pintle plate had been put down to replace the one previously broken. Gun washed out and examined after each round. Powder put up April 26, 1896. Scott sight No. 627 used. Block opened and closed at an elevation of 8°. Round 216: Elevating band tightened. Pintle pin jumped up 2½ inches. Elevating band moved ¼ inch more upon firing. Round 217: Great difficulty was experienced in removing primer. A monkey wrench had to be used. Pintle pin jumped up ½ inch; driven down. Round 218: Elevating band moved ½ inch. Pintle pin jumped up 6 inches; driven down. Vaseline was used on primer and it came out easily. Round 219: The pintle pin jumped nearly out, allowing the carriage to move back about ½ inch. The carriage was jacked back and pintle pin driven down. The elevating band was loosened, and strips of paper placed under it, after which it held very well. Round 220: The pintle pin acted the same as in previous round. The left lug on top part of elevating band cracked. After this firing the pintle pin had a set screw fitted to it to retain it in position.
6	6		....	3.5	....	3.5	....	3.3	1.1	...	
6	6			0	....	1.5	0.2	....	3.1	....	
6	6		1	....	....	5.5	1.2	....	....	0.9	
6	6		....	1	....	5.5	....	0.8	....	0.9	
6	6		2.5	....	....	7	2.7	....	....	2.4	

Center of impact: Feet.
Below........................ 0.2
Left 4.6
Mean vertical deviation from center of impact............. 1.64
Mean horizontal deviation from center of impact 1.68
Mean deviation from center of impact........................ 2.349

Record of firing with 12-inch B. L. rifle (steel), type, No. 1 (52 tons),

[Object of firing, to test

Date.	No. of fire.	Powder.				Projectile.		Observed time of flight.	Travel of shot in bore.	Elevation.		Deflection points, right.	In azimuth.	Pressure per square inch of bore.
		Kind.	Weight.		Number of prisms.	Kind.	Weight.							
1896.			*Lbs.*	*Oz.*			*Pounds.*		*Inches.*	°	'			*Pounds.*
May 20	221	Du Pont's brown prismatic, W. Z., lot 6.	111	0	1,146+7	Solid shot, No. 709, large band.	1,005	....	330.85	4	38	.....	....	J, 35,422 I, 35,244
			115	0	1,188+7									
			114	0	1,178+7									
			115	0	1,188+7									
			455	0										
May 20	222		115	0	1,188+7		1,001	....	330.90	5	6	.....	....	J, 36,489 I, 36,422
			115	0	1,188+7									
			114	0	1,178+7									
			111	0	1,146+7									
			455	0										
May 25	223		115	0	1,188+7		1,002	....	330.8	2	0	.....	....	K, 35,400 P, 35,556
			114	0	1,177+7									
			115	0	1,188+7									
			116	0	1,196+7									
			460	0										
May 25	224		115	0	1,188+7		1,003	....	330.8	2	0	.....	....	K, 35,289 P, 36,556
			115	0	1,188+7									
			119	0	1,230+7									
			111	0	1,146+7									
			460	0										
May 26	225		119	0	1,229+7		1,003	....	330.8	2	0	.....	....	K, 35,700 P, 35,900
			115	0	1,188+7									
			115	0	1,189+7									
			111	0	1,147+7									
			460	0										
June 2	226		160	12	1,671	Solid shot, lot 709.	1,003	....	330.7	9	0	.....	....	A, 36,111 X, 36,511
			160	12	1,671									
			142	12	1,483									
				12	Igniter.									
			465	0										
June 2	227		165	12	1,723		1,003½	....	330.7	9	0	.....	....	A, 38,000 X, 37,378
			160	12	1,671									
			137	12	1,431									
				12	Igniter.									
			465	0										

Watervliet Arsenal, at Sandy Hook Proving Ground, etc.—Continued.

accuracy at 3,000 yards.]

Recoil.	Counter recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.	General remarks.
			Powder put up May 18, 1896. To load at this angle the guard railing on the right side was removed in order to swing the block around. Struck 19¼ inches below the point aimed at. There was some difficulty in loading at this angle.	Gun mounted on 12-inch barbette carriage. Fired at a screen to determine jump at various angles. The screen was 400 feet from the muzzle of the gun. Impressions taken after round 225. On May 27 the gun was prepared for a rapidity test, but it was found that a tooth of the pinion of the compound gear of breech mechanism was broken. The face plate was removed and a new tooth put in. The loading platform was increased in length by adding 2 feet 4 inches to the rear.
			Struck 19 inches below the point aimed at.	
			1 pint of oil added to cylinders	
			The shot struck 11 inches below the point aimed at.	
			The shot struck 13 inches below the point aimed at.	
			The shot struck 11⅜ inches below the point aimed at.	The screen was placed 200 feet from muzzle. Firing conducted by Lieut. W. S. Peirce, Ordnance Department, assistant proof officer. For the Board: Isaac Arnold, jr., Major, Ordnance Department, U. S. A., president.
			The shot struck 12¼ inches below the point aimed at.	

Star gauging of 12-inch B. L. rifle (steel), type, No. 1 (52 tons), Watervliet Arsenal, at Sandy Hook Proving Ground—Continued.

LANDS—Continued.

Inches from muzzle.	Original bore before rifling at Watervliet Arsenal.	After 21 rounds, Nov. 12, 1891.	Increase.	After 27 rounds, Mar. 17, 1892.	Increase.	After 32 rounds, Mar. 19, 1892.	Increase.	After 62 rounds, Sept. 1, 1892.	Increase.	After 83 rounds, May 8, 1893.	Increase.	After 111 rounds, Nov. 19, 1894.	Increase.	After 151 rounds, July 8, 1895.	Increase.	After 220 rounds, May 19, 1896.	Increase.	Total increase.
	Inches.	*Inches.*		*Inches.*		*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*			
314	Cored surface measured at arsenal only at ends. Temperature of shop, about 70°.	12.0540						12.0745		12.0760	.0015	12.0875	.0115	12.1060	.0185			
315				12.0580		12.0610	.0030	12.0760	.0150	12.0780	.0020	12.0890	.0110	12.1090	.0200			
316		12.0570						12.0770		12.0800	.0030	12.0920	.0120	12.1100	.0180			
317				12.0600		12.0640	.0040	12.0790	.0150	12.0830	.0040	12.0930	.0100	12.1140	.0210			
318		12.0590						12.0815		12.0845	.0030	12.0950	.0105	12.1170	.0220			
319				12.0640		12.0670	.0030	12.0830	.0160	12.0870	.0040	12.0970	.0100	12.1200	.0230			
320		12.0640						12.0860		12.0885	.0025	12.0990	.0105	12.1210	.0220			
321				12.0660		12.0690	.0030	12.0890	.0200	12.0900	.0010	12.1000	.0100	12.1220	.0220			
322		12.0660						12.0900		12.0915	.0015	12.1030	.0115	12.1250	.0220			
323				12.0680		12.0720	.0040	12.0910	.0190	12.0925	.0015	12.1030	.0105	12.1260	.0230			
324		12.0680						12.0930		12.0945	.0015	12.1050	.0105	12.1290	.0240			
325				12.0700		12.0740	.0040	12.0940	.0200	12.0955	.0015	12.1080	.0125	12.1360	.0280			
326		12.0720																
327	12.0600																	

185	12.0010	12.0030	.0020	12 0010	—.0020	12.0000	—.0010	12.0075	.0075	12.0035	—.0040	12.0050	.0015	12.0070	.0020	12.0140	.0070	.0130
190	12.0010	12.0035	.0025	12.0010	—.0025	12.0010	.0000	12.0080	.0070	12.0050	—.0030	12.0065	.0015	12.0090	.0025	12.0160	.0070	.0150
195	12.0010	12.0020	.0010	12.0010	—.0010	12.0010	.0000	12.0085	.0075	12.0060	—.0025	12.0065	.0005	12.0095	.0030	12.0175	.0080	.0165
200	12.0010	12.0030	.0020	12.0010	—.0020	12.0000	—.0010	12.0080	.0080	12.0050	—.0030	12.0055	.0005	12.0085	.0025	12.0160	.0080	.0150
205	12.0010	12.0030	.0020	12.0010	—.0020	12.0010	.0000	12.0080	.0070	12.0050	—.0030	12.0055	.0005	12.0090	.0035	12.0160	.0070	.0150
210	12.0010	12.0030	.0020	12.0000	—.0030	12.0000	.0000	12.0080	.0080	12.0050	—.0030	12.0060	.0010	12.0090	.0030	12.0170	.0080	.0160
215	12.0010	12.0030	.0020	12.0010	—.0020	12.0010	.0000	12.0090	.0080	12.0075	—.0015	12.0070	—.0005	12.0100	.0030	12.0200	.0100	.0190
220	12.0010	12.0040	.0030	12.0000	—.0040	12.0015	.0015	12.0090	.0075	12.0085	—.0005	12.0070	—.0015	12.0110	.0040	12.0220	.0110	.0210
225	12.0010	12.0035	.0025	12.0010	—.0025	12.0010	.0000	12.0080	.0070	12.0070	—.0010	12.0070	.0000	12.0110	.0040	12.0230	.0120	.0220
230	12.0010	12.0035	.0025	12.0010	—.0025	12.0020	.0010	12.0080	.0060	12.0065	—.0015	12.0075	.0010	12.0120	.0045	12.0250	.0130	.0240
235	12.0010	12.0045	.0035	12.0000	—.0045	12.0010	.0010	12.0090	.0080	12.0070	—.0020	12.0080	.0010	12.0120	.0040	12.0280	.0160	.0270
240	12.0010	12.0010	.0000	12.0000	—.0010	12.0015	.0015	12.0100	.0085	12.0080	—.0020	12.0085	.0005	12.0140	.0055	12.0300	.0160	.0290
245	12.0010	12.0010	.0000	12.0000	—.0010	12.0015	.0015	12.0090	.0075	12.0075	—.0015	12.0090	.0015	12.0150	.0060	12.0320	.0170	.0310
250	12.0010	12.0010	.0000	12.0010	.0000	12.0020	.0010	12.0100	.0080	12.0070	—.0030	12.0090	.0020	12.0160	.0070	12.0360	.0200	.0350
255	12.0010	12.0010	.0000	12.0010	.0000	12.0020	.0010	12.0100	.0080	12.0075	—.0025	12.0100	.0025	12.0170	.0070	12.0380	.0210	.0370
260	12.0010	12.0010	.0000	12.0020	.0010	12.0030	.0010	12.0135	.0105	12.0075	—.0060	12.0110	.0035	12.0190	.0080	12.0420	.0230	.0410
264	......	......	......	......	......	......	......	12.0175	......	......	......	......	......	......	......	......	......	......
265	12.0010	12.0020	.0010	12.0030	.0010	12.0050	.0020	......	......	12.0095	......	12.0130	.0035	12.0220	.0090	12.0520	.0300	......
266	......	......	......	......	......	......	......	12.0190	......	......	......	......	......	......	......	......	......	......
268	......	......	......	......	......	......	......	12.0200	......	......	......	......	......	......	......	......	......	......
270	12.0010	12.0050	.0040	12.0040	—.0010	12.0050	.0010	12.0200	.0150	12.0125	—.0075	12.0170	.0045	12.0265	.0095	12.0530	.0265	.0520
272	12.0010	......	......	12.0060	......	12.0070	.0010	12.0220	.0150	12.0135	—.0085	12.0180	.0045	12.0290	.0110	12.0550	.0260	......
274	12.0010	......	......	12.0060	......	12.0080	.0020	12.0230	.0150	12.0140	—.0090	12.0190	.0050	12.0300	.0110	12.0585	.0285	......
275	......	12.0040	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
276	12.0010	......	......	12.0060	......	12.0070	.0010	12.0240	.0170	12.0155	—.0085	12.0200	.0045	12.0320	.0120	12.0600	.0280	......
278	12.0010	......	......	12.0060	......	12.0080	.0020	12.0250	.0170	12.0170	—.0080	12.0215	.0045	12.0335	.0120	......	......	......
280	Corod surface measured at arsenal only at ends. Temperature of shop, about 70°.	12.0070	......	12.0090	.0020	12.0100	.0010	12.0265	.0165	12.0185	—.0080	12.0245	.0060	12.0360	.0115	......	......	......
282		......	......	12.0110	......	12.0120	.0010	12.0320	.0200	12.0210	—.0110	12.0270	.0060	12.0390	.0120	......	......	......
284		......	......	12.0140	......	12.0150	.0010	12.0310	.0160	12.0245	—.0065	12.0300	.0055	12.0435	.0135	......	......	......
285		12.0140	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
286		......	......	12.0160	......	12.0180	.0020	12.0310	.0130	12.0280	—.0030	12.0335	.0055	12.0465	.0130	......	......	......
288		......	......	12.0180	......	12.0210	.0030	12.0325	.0115	12.0305	—.0020	12.0365	.0060	12.0500	.0135	......	......	......
290		12.0200	......	12.0210	.0010	12.0230	.0020	12.0370	.0140	12.0330	—.0040	12.0400	.0070	12.0530	.0130	......	......	......
292		12.0230	......	12.0240	.0010	12.0270	.0030	12.0390	.0120	12.0360	—.0030	12.0430	.0070	12.0575	.0145	......	......	......
294		12.0260	......	12.0280	.0020	12.0290	.0010	12.0420	.0130	12.0400	—.0020	12.0465	.0065	12.0620	.0155	......	......	......
296		12.0290	......	12.0310	.0020	12.0330	.0020	12.0450	.0120	12.0435	—.0015	12.0510	.0075	12.0660	0150	......	......	......
298		12.0310	......	12.0330	.0020	12.0340	.0010	12.0480	.0140	12.0480	.0000	12.0550	.0070	12.0700	.0150	......	......	......
300		12.0330	......	12.0350	.0020	12.0380	.0030	12.0500	.0120	12.0515	.0015	12.0595	.0080	12.0745	.0150	......	......	......
301		......	......	12.0400	......	12.0440	.0040	12.0510	.0070	12.0530	.0020	12.0605	.0075	12.0765	.0160	......	......	......
302		12.0350	......	......	......	......	......	12.0535	......	12.0540	.0005	12.0620	.0080	12.0780	.0160	......	......	......
303		......	......	12.0420	......	12.0460	.0040	12.0550	.0090	12.0560	.0010	12.0640	.0080	12.0810	.0170	......	......	......
304		12.0390	......	......	......	......	......	12.0570	......	12.0580	.0010	12.0660	.0080	12.0820	.0160	......	......	......
305		......	......	12.0440	......	12.0480	.0040	12.0595	.0115	12.0600	.0005	12.0680	.0080	12.0840	.0160	......	......	......
306		12.0420	......	......	......	......	......	12.0600	......	12.0620	.0020	12.0700	.0080	12.0870	.0170	......	......	......
307		......	......	12.0460	......	12.0500	.0040	12.0630	.0130	12.0645	.0015	12.0725	.0080	12.0900	.0175	......	......	......
308		12.0450	......	......	......	......	......	12.0640	......	12.0655	.0015	12.0740	.0085	12.0920	.0180	......	......	......
309		......	......	12.0500	......	12.0520	.0020	12.0595	.0075	12.0670	.0075	12.0760	.0090	12.0940	.0180	......	......	......
310		12.0480	......	......	......	......	......	12.0670	......	12.0685	.0015	12.0785	.0100	12.0960	.0175	......	......	......
311		......	......	12.0530	......	12.0550	.0020	12.0690	.0140	12 0705	.0015	12.0810	.0105	12.0990	.0180	......	......	......
312		12.0500	......	......	......	......	......	12.0710	......	12.0730	.0020	12.0835	.0105	12.1025	.0190	......	......	......
313		......	......	12.0560	......	12.0580	.0020	12.0720	.0140	12.0740	.0020	12.0860	.0120	12.1030	.0170	......	......	......

Star gauging of 12-inch B. L. rifle (steel), type, No. 1 (52 tons), Watervliet Arsenal, at Sandy Hook Proving Ground—Continued.

LANDS—Continued.

Inches from muzzle.	Original bore before rifling at Watervliet Arsenal.	After 21 rounds, Nov. 12, 1891.	Increase.	After 27 rounds, Mar. 17, 1892.	Increase.	After 32 rounds, Mar. 19, 1892.	Increase.	After 62 rounds, Sept. 1, 1892.	Increase.	After 83 rounds, May 8, 1893.	Increase.	After 111 rounds, Nov. 19, 1894.	Increase.	After 151 rounds, July 8, 1895.	Increase.	After 220 rounds, May 19, 1896.	Increase.	Total increase.
	Inches.	*Inches.*		*Inches.*		*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*			
314	Cored surface measured at arsenal only at ends. Temperature of shop, about 70°.	12.0540						12.0745		12.0760	.0015	12.0875	.0115	12.1060	.0185			
315				12.0580		12.0610	.0030	12.0760	.0150	12.0780	.0020	12.0890	.0110	12.1090	.0200			
316		12.0570						12.0770		12.0800	.0030	12.0920	.0120	12.1100	.0180			
317				12.0600		12.0640	.0040	12.0790	.0150	12.0830	.0040	12.0930	.0100	12.1140	.0210			
318		12.0590						12.0815		12.0845	.0030	12.0950	.0105	12.1170	.0220			
319				12.0640		12.0670	.0030	12.0830	.0160	12.0870	.0040	12.0970	.0100	12.1200	.0230			
320		12.0640						12.0860		12.0885	.0025	12.0990	.0105	12.1210	.0220			
321				12.0660		12.0690	.0030	12.0890	.0200	12.0900	.0010	12.1000	.0100	12.1220	.0220			
322		12.0660						12.0900		12.0915	.0015	12.1030	.0115	12.1250	.0220			
323				12.0680		12.0720	.0040	12.0910	.0190	12.0925	.0015	12.1030	.0105	12.1260	.0230			
324		12.0680						12.0930		12.0945	.0015	12.1050	.0105	12.1290	.0240			
325				12.0700		12.0740	.0040	12.0940	.0200	12.0955	.0015	12.1080	.0125	12.1360	.0280			
326		12.0720																
327	12.0600																	

304	12.1190 to 12.1200 inches. Temperature of which were as	....	....	....	12.1250	....	12.1315	.0065	12.1840	.0025	12.1495	.0155	....	....
305		12.1170	12.1185	.0015	12.1270	.0085	12.1320	.0050	12.1330	.0010	12.1495	.0165	....	....
306		....	....	....	12.1260	....	12.1330	.0070	12.1330	.0000	12.1530	.0200	....	....
307		12.1160	12.1195	.0035	12.1280	.0085	12.1335	.0055	12.1380	.0045	12.1535	.0155	....	....
308		....	....	....	12.1285	....	12.1345	.0060	12.1360	.0015	12.1510	.0150	....	....
309		12.1175	12.1195	.0020	12.1280	.0085	12.1340	.0060	12.1350	.0010	12.1510	.0160	....	....
310		....	....	....	12.1280	....	12.1350	.0070	12.1370	.0020	12.1560	.0190	....	....
311		12.1195	12.1200	.0005	12.1290	.0090	12.1370	.0080	12.1395	.0025	12.1610	.0215	....	....
312		....	....	....	12.1300	....	12.1360	.0060	12.1420	.0060	12.1570	.0150	....	....
313		12.1210	12.1215	.0005	12.1300	.0085	12.1360	.0060	12.1430	.0070	12.1620	.0190	....	....
314		....	....	....	12.1350	....	12.1370	.0020	12.1420	.0050	12.1620	.0200	....	....
315		12.1210	12.1215	.0005	12.1320	.0105	12.1385	.0065	12.1420	.0035	12.1650	.0230	....	....
316		....	....	....	12.1340	....	12.1385	.0045	12.1420	.0035	12.1635	.0215	....	....
317		12.1215	12.1225	.0010	12.1310	.0085	12.1395	.0085	12.1420	.0025	12.1670	.0250	....	....
318		....	....	....	12.1340	....	12.1405	.0065	12.1460	.0055	12.1755	.0295	....	....
319		12.1225	12.1225	.0000	12.1350	.0125	12.1420	.0070	12.1490	.0070	12.1720	.0230	....	....
320		....	....	....	12.1355	....	12.1420	.0065	12.1490	.0070	12.1710	.0220	....	....
321		12.1210	12.1225	.0015	12.1350	.0125	12.1415	.0065	12.1500	.0085	12.1640	.0140	....	....
322		....	....	....	12.1350	....	12.1405	.0055	12.1480	.0075	12.1680	.0200	....	....
323		12.1215	12.1220	.0005	12.1340	.0120	12.1390	.0050	12.1470	.0080	12.1680	.0210	....	....
324		....	....	....	12.1340	....	12.1410	.0070	12.1480	.0070	12.1700	.0220	....	....
325		12.1215	12.1215	.0000	12.1340	.0125	12.1385	.0045	12.1470	.0085	12.1720	.0250	....	....

Star gauging of 12-inch B. L. rifle (steel), type, No. 1 (52 tons), Watervliet Arsenal, at Sandy Hook Proving Ground—Continued.

GROOVES—Continued.

Inches from muzzle.	Original bore at Watervliet Arsenal.	After 27 rounds, March 17, 1892.	After 32 rounds, March 19, 1892.	Increase.	After 62 rounds, Sept. 2, 1892.	Increase.	After 83 rounds, May 8, 1893.	Increase.	After 111 rounds, Nov. 19, 1894.	Increase.	After 151 rounds, July 8, 1895.	Increase.	After 220 rounds, May 19, 1896.	Increase.
		Inches.	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*
190	shop, about 70°. The mean given is that of all the grooves, some of small as the measurement of Mar. 17, 1892.	12.1150	12.1160	.0010	12.1210	.0050	12.1215	.0005	12.1200	—.0015	12.1235	.0035	12.1290	.0055
195		12.1150	12.1160	.0010	12.1220	.0060	12.1225	.0005	12.1200	—.0025	12.1225	.0025	12.1310	.0085
200		12.1150	12.1160	.0010	12.1215	.0055	12.1205	—.0010	12.1200	—.0005	12.1210	.0010	12.1300	.0090
205		12.1150	12.1150	.0000	12.1210	.0060	12.1205	—.0005	12.1200	—.0005	12.1240	.0040	12.1360	.0120
210		12.1150	12.1150	.0000	12.1220	.0070	12.1210	—.0010	12.1200	—.0010	12.1210	.0010	12.1280	.0070
215		12.1160	12.1170	.0010	12.1210	.0040	12.1225	.0015	12.1210	—.0015	12.1250	.0040	12.1320	.0070
220		12.1160	12.1160	.0000	12.1210	.0050	12.1210	.0000	12.1215	.0005	12.1255	.0040	12.1320	.0065
225		12.1150	12.1150	.0000	12.1200	.0050	12.1210	.0010	12.1200	—.0010	12.1225	.0025	12.1360	.0135
230		12.1140	12.1150	.0010	12.1200	.0050	12.1215	.0015	12.1215	.0000	12.1250	.0035	12.1400	.0150
235		12.1150	12.1150	.0000	12.1190	.0040	12.1220	.0030	12.1225	.0005	12.1255	.0030	12.1390	.0135
240		12.1155	12.1160	.0005	12.1190	.0030	12.1225	.0035	12.1220	—.0005	12.1270	.0050	12.1430	.0160
245		12.1145	12.1160	.0015	12.1200	.0040	12.1225	.0025	12.1225	.0000	12.1245	.0020	12.1400	.0155
250		12.1140	12.1160	.0020	12.1190	.0030	12.1210	.0020	12.1230	.0020	12.1280	.0050	12.1470	.0190
255		12.1130	12.1160	.0030	12.1190	.0030	12.1220	.0030	12.1230	.0010	12.1320	.0090	12.1520	.0200
260		12.1140	12.1160	.0020	12.1180	.0020	12.1220	.0040	12.1235	.0015	12.1310	.0075	12.1500	.0190
264		....	....	....	12.1180	....	....	....	....	....	....	....	....	....
265		12.1160	12.1170	.0010	....	....	12.1240	....	12.1230	—.0010	12.1280	.0050	12.1500	.0220
266		....	....	....	12.1190	....	....	....	....	....	....	....	....	....
268		....	....	....	12.1200	....	....	....	....	....	....	....	....	....
270		12.1160	12.1160	.0000	12.1210	.0050	12.1260	.0050	12.1270	.0010	12.1250	—.0020	12.1760	.0510
272		12.1160	12.1160	.0000	12.1210	.0050	12.1250	.0040	12.1250	.0000	12.1330	.0080	12.1630	.0300
274		12.1160	12.1180	.0020	12.1220	.0040	12.1255	.0035	12.1260	.0005	12.1320	.0060	12.1920	.0600
276		12.1170	12.1190	.0020	12.1225	.0035	12.1260	.0035	12.1260	.0000	12.1340	.0080	12.1700	.0360
278		12.1160	12.1180	.0020	12.1210	.0030	12.1250	.0040	12.1260	.0010	12.1335	.0075	12.2000	.0665
280		12.1150	12.1170	.0020	12.1210	.0040	12.1240	.0030	12.1250	.0010	12.1340	.0090	....	....
282		12.1135	12.1170	.0035	12.1220	.0050	12.1245	.0025	12.1265	.0020	12.1350	.0085	....	....
284		12.1130	12.1160	.0030	12.1210	.0050	12.1245	.0035	12.1260	.0015	12.1340	.0080	....	....
286		12.1130	12.1160	.0030	12.1250	.0090	12.1245	—.0005	12.1270	.0025	12.1360	.0090	....	....
288		12.1130	12.1160	.0030	12.1200	.0040	12.1250	.0050	12.1280	.0030	12.1420	.0040	....	....
290		12.1120	12.1160	.0040	12.1210	.0050	12.1245	.0035	12.1300	.0055	12.1440	.0140	....	....
292		12.1130	12.1160	.0030	12.1230	.0070	12.1255	.0025	12.1270	.0015	12.1375	.0105	....	....
294		12.1130	12.1170	.0040	12.1230	.0060	12.1265	.0035	12.1280	.0015	12.1420	.0140	....	....
296		12.1120	12.1170	.0050	12.1240	.0070	12.1290	.0050	12.1310	.0020	12.1460	.0150	....	....
298		12.1140	12.1160	.0020	12.1245	.0085	12.1285	.0040	12.1330	.0045	12.1460	.0130	....	....
300		12.1140	12.1170	.0030	12.1250	.0080	12.1305	.0055	12.1330	.0025	12.1465	.0135	....	....
301		12.1165	12.1185	.0020	12.1235	.0050	12.1305	.0070	12.1340	.0035	12.1500	.0160	....	....
302		....	....	....	12.1260	....	12.1300	.0040	12.1340	.0040	12.1510	.0170	....	....
303		12.1150	12.1185	.0035	12.1250	.0115	12.1310	.0060	12.1345	.0035	12.1505	.0160	....	....

304	Temperature of which were as 12.1190 to 12.1200 inches.				12.1250		12.1315	.0065	12.1340	.0025	12.1495	.0155		
305		12.1170	12.1185	.0015	12.1270	.0085	12.1320	.0050	12.1330	.0010	12.1495	.0165		
306					12.1260		12.1330	.0070	12.1330	.0000	12.1530	.0200		
307		12.1160	12.1195	.0035	12.1280	.0085	12.1335	.0055	12.1380	.0045	12.1535	.0155		
308					12.1285		12.1345	.0060	12.1360	.0015	12.1510	.0150		
309		12.1175	12.1195	.0020	12.1280	.0085	12.1340	.0060	12.1350	.0010	12.1510	.0160		
310					12.1280		12.1350	.0070	12.1370	.0020	12.1560	.0190		
311		12.1195	12.1200	.0005	12.1290	.0090	12.1370	.0080	12.1395	.0025	12.1610	.0215		
312					12.1300		12.1360	.0060	12.1420	.0060	12.1570	.0150		
313		12.1210	12.1215	.0005	12.1300	.0085	12.1360	.0060	12.1430	.0070	12.1620	.0190		
314					12.1350		12.1370	.0020	12.1420	.0050	12.1620	.0200		
315		12.1210	12.1215	.0005	12.1320	.0105	12.1385	.0065	12.1420	.0035	12.1650	.0230		
316					12.1340		12.1385	.0045	12.1420	.0035	12.1635	.0215		
317		12.1215	12.1225	.0010	12.1310	.0085	12.1395	.0085	12.1420	.0025	12.1670	.0250		
318					12.1340		12.1405	.0065	12.1460	.0055	12.1755	.0295		
319		12.1225	12.1225	.0000	12.1350	.0125	12.1420	.0070	12.1490	.0070	12.1720	.0230		
320					12.1355		12.1420	.0065	12.1490	.0070	12.1710	.0220		
321		12.1210	12.1225	.0015	12.1350	.0125	12.1415	.0065	12.1500	.0085	12.1640	.0140		
322					12.1350		12.1405	.0055	12.1480	.0075	12.1680	.0200		
323		12.1215	12.1220	.0005	12.1340	.0120	12.1390	.0050	12.1470	.0080	12.1680	.0210		
324					12.1340		12.1410	.0070	12.1480	.0070	12.1700	.0220		
325		12.1215	12.1215	.0000	12.1340	.0125	12.1385	.0045	12.1470	.0085	12.1720	.0250		

Star gauging of 12-inch B. L. rifle (steel), type, No. 1 (52 tons), Watervliet Arsenal, at Sandy Hook Proving Ground—Continued.

CHAMBER HORIZONTAL.

Inches from breech.	Original bore at Watervliet Arsenal.	After 27 rounds, Mar. 17, 1892.	Increase.	After 32 rounds, Mar. 19, 1892.	Increase.	After 62 rounds, Sept. 1, 1892.	Increase.	After 83 rounds, May 8, 1893.	Increase.	After 111 rounds, Nov. 19, 1894.	Increase.	After 151 rounds, July 8, 1895.	Increase.	After 220 rounds, May 19, 1896.	Increase.	Total increase.
	Inches.	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inches.*	*Inch.*	*Inch.*
29	14.2035	14.2000	—.0035	14.2005	.0005	14.2060	.0055	14.2220	.0160	14.2280	.0060	14.2270	—.0010	14.2280	.0010	.0245
31	14.2045	14.1975	—.0070	14.1975	.0000	14.2040	.0065	14.2125	.0085	14.2150	.0025	14.2140	—.0010	14.2135	—.0005	.0090
33	14.2045	14.1975	—.0070	14.1975	.0000	14.2025	.0050	14.2090	.0065	14.2110	.0020	14.2095	—.0015	14.2080	—.0015	.0035
35	14.2045	14.1865	—.0180	14.1980	.0115	14.2035	.0055	14.2070	.0035	14.2090	.0020	14.2080	—.0010	14.2060	—.0020	.0015
37	14.2045	14.1865	—.0180	14.1985	.0120	14.2035	.0050	14.2070	.0035	14.2080	.0010	14.2070	—.0010	14.2050	—.0020	.0005
39	14.2045	14.1975	—.0070	14.1985	.0010	14.2030	.0045	14.2055	.0025	14.2065	.0010	14.2050	—.0015	14.2035	—.0015	—.0010
41	14.2045	14.1985	—.0060	14.1990	.0005	14.2050	.0060	14.2055	.0005	14.2065	.0010	14.2060	—.0005	14.2040	—.0020	—.0005
43	14.2045	14.1990	—.0055	14.1990	.0000	14.2050	.0060	14.2045	—.0005	14.2060	.0015	14.2055	—.0005	14.2040	—.0015	—.0005
45	14.2045	14.1980	—.0065	14.1990	.0010	14.2050	.0060	14.2050	.0000	14.2060	.0010	14.2050	—.0010	14.2035	—.0015	—.0010
47	14.2045	14.1990	—.0055	14.1995	.0005	14.2050	.0055	14.2050	.0000	14.2065	.0015	14.2055	—.0010	14.2040	—.0015	—.0005
49	14.2045	14.1985	—.0060	14.2000	.0015	14.2050	.0050	14.2050	.0000	14.2065	.0015	14.2060	—.0005	14.2045	—.0015	.0000
51	14.2045	14.1975	—.0070	14.2000	.0025	14.2060	.0060	14.2060	.0000	14.2070	.0010	14.2070	.0000	14.2050	—.0020	.0005
53	14.2045	14.2000	—.0045	14.2005	.0005	14.2060	.0055	14.2060	.0000	14.2080	.0020	14.2080	.0000	14.2070	—.0010	.0025
55	14.2045	14.1995	—.0050	14.2005	.0010	14.2060	.0055	14.2065	.0005	14.2090	.0025	14.2080	—.0010	14.2070	—.0010	.0025
57	14.2045	14.1995	—.0050	14.2000	.0005	14.2060	.0060	14.2070	.0010	14.2090	.0020	14.2090	.0000	14.2080	—.0010	.0035
59	14.2045	14.1995	—.0050	14.1995	.0000	14.2060	.0065	14.2070	.0010	14.2090	.0020	14.2090	.0000	14.2080	—.0010	.0035
61	14.2045	14.1995	—.0050	14.2000	.0005	14.2070	.0070	14.2080	.0010	14.2100	.0020	14.2100	.0000	14.2095	—.0005	.0050
63	14.2045	14.2005	—.0040	14.2005	.0000	14.2075	.0070	14.2090	.0015	14.2105	.0015	14.2110	.0005	14.2110	.0000	.0065
65	14.2045	14.2015	—.0030	14.2010	—.0005	14.2090	.0080	14.2110	.0020	14.2130	.0020	14.2150	.0020	14.2170	.0020	.0125
67	14.2045	14.2015	—.0030	14.2015	.0000	14.2100	.0085	14.2110	.0010	14.2140	.0030	14.2150	.0010	14.2170	.0020	.0125
69	14.2045	14.2015	—.0030	14.2015	.0000	14.2105	.0090	14.2120	.0015	14.2150	.0030	14.2160	.0010	14.2190	.0030	.0145
71	14.2045	14.2015	—.0030	14.2015	.0000	14.2100	.0085	14.2125	.0025	14.2155	.0030	14.2180	.0025	14.2210	.0030	.0165
73	14.2045	14.2015	—.0030	14.2015	.0000	14.2100	.0085	14.2130	.0030	14.2150	.0020	14.2165	.0015	14.2210	.0045	.0165
75	14.2045	14.2015	—.0030	14.2015	.0000	14.2100	.0085	14.2120	.0020	14.2155	.0035	14.2170	.0015	14.2220	.0050	.0175
77	14.2045	14.1995	—.0050	14.2015	.0020	14.2100	.0085	14.2135	.0035	14.2170	.0035	14.2200	.0030	14.2280	.0080	.0235
79	14.2045	14.2015	—.0030	14.2015	.0000	14.2120	.0105	14.2155	.0035	14.2190	.0035	14.2230	.0040	14.2280	.0050	.0235
81	14.2045	14.2015	—.0030	14.2015	.0000	14.2120	.0105	14.2150	.0030	14.2195	.0045	14.2240	.0045	14.2330	.0090	.0285
83	14.2045	14.2010	—.0035	14.2020	.0010	14.2120	.0100	14.2160	.0040	14.2190	.0030	14.2250	.0060	14.2360	.0110	.0315
85	14.2045	14.2025	—.0020	14.2025	.0000	14.2130	.0105	14.2175	.0045	14.2220	.0045	14.2275	.0055	14.2400	.0125	.0355
87	14.2045	14.2020	—.0025	14.2035	.0015	14.2150	.0115	14.2200	.0050	14.2230	.0030	14.2295	.0065	14.2435	.0140	.0390
89	14.2045	14.2025	—.0020	14.2035	.0010	14.2150	.0115	14.2180	.0030	14.2230	.0050	14.2300	.0070	14.2470	.0170	.0425
91	14.2045	14.2030	—.0015	14.2035	.0005	14.2160	.0125	14.2210	.0050	14.2245	.0035	14.2320	.0075	14.2480	.0160	.0435
93	14.2045	14.2030	—.0015	14.2035	.0005	14.2170	.0135	14.2195	.0025	14.2240	.0045	14.2320	.0080	14.2500	.0180	.0455
95	14.2045	14.2015	—.0030	14.2030	.0015	14.2180	.0100	14	....	14.2220	....	14.2300	.0080	14.2445	.0145	....

CHAMBER VERTICAL.

29	14.2035	14.1995	—.0040	14.2000	.0005	14.2070	.0070	14.2260	.0190	14.2310	.0050	14.2270	—.0040	14.2280	.0010	.0245
31	14.2045	14.1980	—.0065	14.1985	.0005	14.2040	.0055	14.2150	.0110	14.2170	.0020	14.2155	—.0015	14.2140	—.0015	.0095
33	14.2045	14.1975	—.0070	14.1975	.0000	14.2030	.0055	14.2115	.0085	14.2120	.0005	14.2110	—.0010	14.2100	—.0010	.0055
35	14.2045	14.1975	—.0070	14.1975	.0000	14.2035	.0060	14.2100	.0065	14.2100	.0000	14.2095	—.0005	14.2075	—.0020	.0030
37	14.2045	14.1975	—.0070	14.1985	.0010	14.2040	.0055	14.2080	.0045	14.2090	.0005	14.2080	—.0010	14.2060	—.0020	.0015
39	14.2045	14.1985	—.0060	14.1985	.0000	14.2040	.0055	14.2085	.0045	14.2085	.0000	14.2070	—.0015	14.2060	—.0010	.0015
41	14.2045	14.1995	—.0050	14.1990	—.0005	14.2050	.0060	14.2080	.0030	14.2080	.0000	14.2075	—.0005	14.2055	—.0020	.0010
43	14.2045	14.1990	—.0055	14.1990	.0000	14.2050	.0060	14.2075	.0025	14.2070	—.0005	14.2065	—.0005	14.2050	—.0015	.0005
45	14.2045	14.1995	—.0050	14.1995	.0000	14.2050	.0055	14.2060	.0010	14.2070	.0010	14.2065	—.0005	14.2050	—.0015	.0005
47	14.2045	14.2000	—.0045	14.1995	—.0005	14.2055	.0060	14.2065	.0010	14.2080	.0015	14.2070	—.0010	14.2065	—.0005	.0020
49	14.2045	14.2005	—.0040	14.1995	—.0010	14.2050	.0055	14.2080	.0030	14.2075	—.0005	14.2080	.0005	14.2060	—.0020	.0015
51	14.2045	14.2005	—.0040	14.2005	.0000	14.2060	.0055	14.2080	.0020	14.2090	.0010	14.2085	—.0005	14.2080	—.0005	.0035
53	14.2045	14.2010	—.0035	14.2005	—.0005	14.2065	.0060	14.2090	.0025	14.2100	.0010	14.2100	.0000	14.2090	—.0010	.0045
55	14.2045	14.2005	—.0040	14.2005	.0000	14.2065	.0060	14.2100	.0035	14.2100	.0000	14.2105	.0005	14.2095	—.0010	.0050
57	14.2045	14.1995	—.0050	14.2005	.0010	14.2070	.0065	14.2100	.0030	14.2115	.0015	14.2120	.0005	14.2120	.0000	.0075
59	14.2045	14.2000	—.0045	14.2005	.0005	14.2070	.0065	14.2100	.0030	14.2110	.0010	14.2125	.0015	14.2135	.0010	.0090
61	14.2045	14.2005	—.0040	14.2000	—.0005	14.2080	.0080	14.2110	.0030	14.2130	.0020	14.2130	.0000	14.2160	.0030	.0115
63	14 2045	14.2005	—.0040	14.2005	.0000	14.2085	.0080	14.2125	.0040	14.2140	.0015	14.2145	.0005	14.2180	.0035	.0135
65	14.2045	14.2005	—.0040	14.2010	.0005	14.2095	.0085	14.2150	.0055	14.2170	.0020	14.2185	.0015	14.2230	.0045	.0185
67	14.2045	14.2015	—.0030	14.2015	.0000	14.2100	.0085	14.2140	.0040	14.2170	.0030	14.2185	.0015	14.2245	.0060	.0200
69	14.2045	14.2015	—.0030	14.2020	.0005	14.2110	.0090	14.2140	.0030	14.2190	.0050	14.2215	.0025	14.2260	.0045	.0215
71	14.2045	14.2010	—.0035	14.2015	.0005	14.2105	.0090	14.2140	.0035	14.2180	.0040	14.2225	.0045	14.2290	.0065	.0245
73	14.2045	14.2015	—.0030	14.2015	.0000	14.2100	.0085	14.2140	.0040	14.2170	.0030	14.2185	.0015	14.2250	.0065	.0205
75	14.2045	14.2015	—.0030	14.2015	.0000	14.2105	.0090	14.2135	.0030	14.2170	.0035	14.2230	.0060	14.2315	.0085	.0270
77	14.2045	14.2015	—.0030	14.2015	.0000	14.2100	.0085	14.2150	.0050	14.2170	.0020	14.2210	.0040	14.2330	.0120	.0285
79	14.2045	14.2015	—.0030	14.2015	.0000	14.2110	.0095	14.2160	.0050	14.2190	.0030	14.2230	.0040	14.2360	.0130	.0315
81	14.2045	14.2015	—.0030	14.2020	.0005	14.2115	.0095	14.2150	.0035	14.2195	.0045	14.2230	.0035	14.2360	.0130	.0315
83	14.2045	14.2016	—.0030	14.2020	.0005	14.2130	.0110	14.2170	.0040	14.2210	.0040	14.2255	.0045	14.2395	.0140	.0350
85	14.2045	14.2030	—.0015	14.2030	.0000	14.2140	.0110	14.2190	.0050	14.2220	.0030	14.2285	.0065	14.2430	.0145	.0385
87	14.2045	14.2030	—.0015	14.2035	.0005	14.2150	.0115	14.2185	.0035	14.2230	.0045	14.2320	.0090	14.2490	.0170	.0445
89	14.2045	14.2035	—.0010	14.2050	.0015	14.2150	.0100	14.2190	.0040	14.2250	.0060	14.2300	.0050	14.2465	.0165	.0420
91	14.2045	14.2035	—.0010	14.2045	.0010	14.2160	.0115	14.2200	.0040	14.2240	.0040	14.2330	.0090	14.2530	.0200	.0485
93	14.2045	14.2035	—.0010	14.2040	.0005	14.2150	.0110	14.2190	.0040	14.2250	.0060	14.2330	.0080	14.2490	.0160	.0445
95	14.2045	14.2025	—.0020	14.2030	.0005	14.2150	.0120	14.	....	14.2210	....	14.2300	.0090	14.2500	.0200	....

Record of firing with 12-inch B. L. rifle (steel), No. 16, model

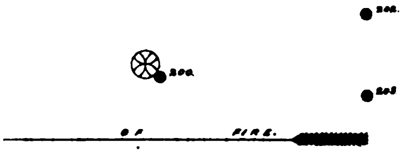
[Object of firing, rapidity test before

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Pressure per square inch of bore.	Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.				
1896.			*Pounds.*		*Pounds.*	°	*Pounds.*	*Feet.*	
Aug. 26	17	Du Pont's brown prismatic, W. Z. Lot 4.	455	Shot rebanded.	993	10	35, 511 35, 800	4	Wind from right and rear, 40°, 7 miles an hour; barometer, 30.19; thermometer, 74°; humidity, 62.
Aug. 26	18		455		996	10	34, 444 34, 267	4	
Aug. 26	19	Lot 6.	465		987	10	37, 644 37, 860	4	
Aug. 27	20		465		996	10	37, 667 43, 181	4	
Aug. 27	21		465		996	10	35, 980 40, 900	4	
Aug. 27	22	Lot 4.	455		997	....	....	....	
Aug. 27	23		455		991	....	....	....	
Aug. 27	24		455		993	....	....	....	
Aug. 27	25		455		996	....	....	....	
Aug. 27	26		455		998	....	....	....	
Aug. 27	27		455		996	....	....	....	
Aug. 27	28		455		997	....	....	....	
Aug. 27	29		455		991	....	....	....	
Aug. 27	30		455		998	....	....	....	
Aug. 27	31		455		1, 000	....	....	....	

1888, at Sandy Hook Proving Ground, August 26 and 27, 1896.

the Board for Testing Rifled Cannon.]

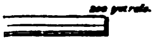
General remarks.
Rounds 17 to 21, inclusive, were fired to test condition of bore of gun. Commenced at 12.03 p. m. First fire, 12.05.25; second fire, 12.09.20; third fire, 12.12.30. Delay at 12.13.17; duration, 4 minutes 16 seconds; cause, breech mechanism becoming hard to operate, and requiring oiling. Fourth fire at 12.20.13 p. m. Delay at 12.26; duration, 1 minute 26 seconds; cause, breech mechanism requiring adjustment. Delay at 12.28 p. m.; duration, 1 minute 17 seconds; cause, shipping. Fifth fire at 12.29.37 p. m. Total time, 26 minutes 37 seconds; net time, 25 minutes 20 seconds. Commenced at 4.23 p. m. First fire, 4.25; second fire, 4.27.28. Delay at 4.30.06; duration, 26 seconds; cause, traversing. Third fire at 4.30.32 p. m. Delay at 4.31.15; duration, 3 minutes 27 seconds; cause, shipping. Fourth fire at 4.37.08. Delay at 4.37.45; duration, 1 minute; cause, removal of primer. Delay at 4.41.35; duration, 13 minutes 37 seconds; cause, shot sticking in chamber. Fifth fire at 4.55.22 p. m. Total time, 32 minutes 22 seconds; delays, 19 minutes; net time, 13 minutes 22 seconds. Gun mounted on 12-inch barbette carriage, Watertown Arsenal, No. 1. Fired to sea. Considerable difficulty was experienced in translating and rotating the block in this test, as noted in the table. After the trial the breech mechanism was taken apart for examination. It was found that the spring washer on the spindle had become displaced, getting between the obturator nut and the rear antifriction washer. As a result the gas check was unduly expanded and fitted its seat too closely. The spring washer and the front face of the obturator nut bore marks of cutting. The translating stud was also scored slightly. This was repaired and the breech mechanism reassembled for another rapidity test. Impressions taken Aug. 27 after rounds 19 and 31. Firing conducted by Lieut. W. S. Peirce, Ordnance Department, in the presence of the Board for Testing Rifled Cannon. For the Board: Isaac Arnold, jr., Major, Ordnance Department, U. S. A., president.



5625·2 yards.
11·8 "
29·04 "
3·36 "
73·0 "
15·0 "
ular Dev. from plane of fire 0° 7' 12"
jectile, 1004 lbs. Elevation, 5°. Fired, April 25th 1896

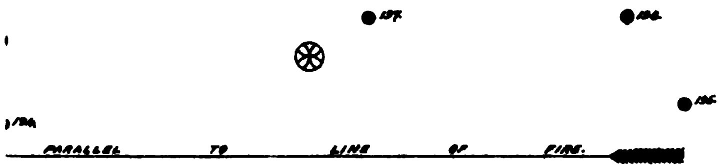
—WIND—TABLE.—

[illegible]	Direction		Miles per hour
199	from right	90°	12
200	" "	90°	10
201	" "	90°	9
202	" right & front	25°	9
203	" " " "	25°	9



Ord 54 2

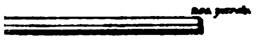
Plate II.



4259·4 yards.
82·6 "
47·68 "
7·44 "
150·0 "
17·0 "
r Deviation from Plane of fire, 0° 23′ 13″
cile 1004 lbs. Elevation, 15°. Fired, April 23rd 1896.

WIND TABLE.

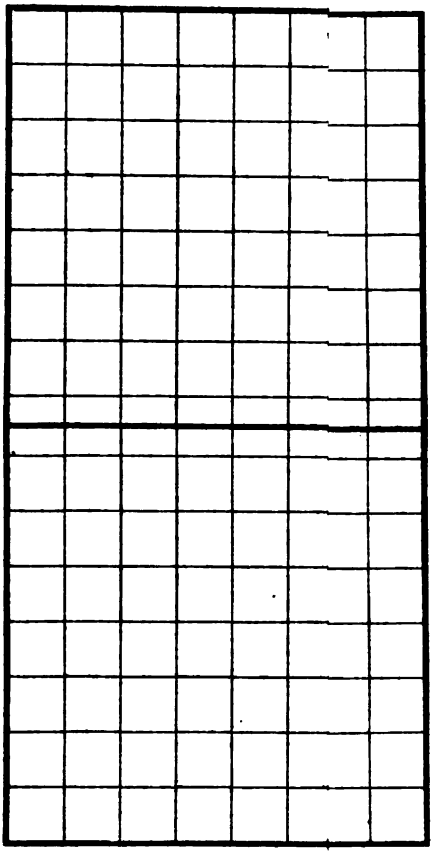
[illegible]	[illegible]	[illegible]
194	from front	11
195	" "	11
196	" "	16
197	" "	12
198	" "	12



Ord 54 2

TARGET Roth Lift, New Gun Lift
(Battery.

Number of shots fired, 6



● *Center of impact.*

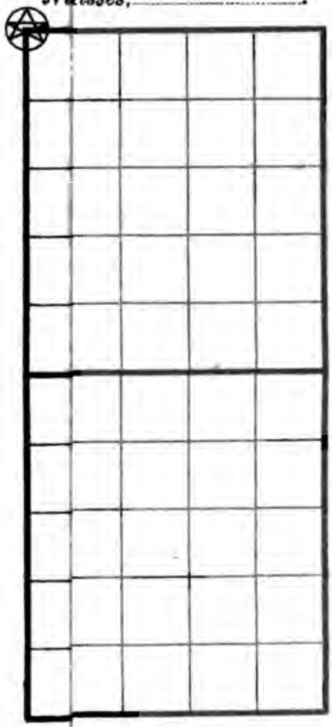
⊛ *Point aimed at.*

Target 30 × 44

Ord 54 2

N. J. *May 6th 1896.*

N Misses, ...



⊛ *4 feet* ....

1·68 " ....

✪ *t* ....

Appendix 30, 1896. Ord 54 2

APPENDIX 31.

REPORT ON THE CONSTRUCTION OF A BATTERY AT QUONSET POINT, RHODE ISLAND.

(3 plates.)

WATERTOWN ARSENAL,
Watertown, Mass., July 1, 1896.

SIR: I have the honor to make the following report upon the construction of a battery for the State of Rhode Island, under the act of Congress approved May 19, 1882, and your letter of instructions of March 16, 1895.

Upon receipt of your letter I communicated with the governor of the State, informing him of my instructions and, in response to my request, appointment was made to meet the State camp ground commission for the selection of a site. On May 9 I visited the ground, and in conjunction with the commission selected that upon which the battery stands. This is at the head of West Passage between Conanicut Island and the main land and has an ample range down the sound for practice with the guns and mortars. It is at one side of the camp ground and will never interfere, either by its location or use at drill, with any possible future occupation of the ground in its vicinity. This feature was of great weight in the selection. The site was also favorable to construction and accessible for delivery of materials.

It was proposed to construct the battery by contract on the lines followed by Maj. John E. Greer, Ordnance Department, in building one at Peekskill, N. Y., with the exception that the revetment wall to gun battery and magazine should be of stone instead of timber. Proposals were accordingly invited for furnishing all labor and materials used in construction of the battery, mounting the guns, mortars, etc., the United States to deliver guns, mortars, and carriages on the ground. Bids were opened June 27, 1895, but were not satisfactory, and were by your authority rejected and the construction of the work undertaken in detail.

The amounts of the bids received in answer to the advertisement were such as to lead to a reduction in the length of the parapet and other dimensions so as to bring the cost within the appropriation and yet give ample scope for all practical purposes.

Separate satisfactory bids having been obtained for furnishing the material, delivering guns, mortars, etc., and construction of the stone work, parapet, magazine, etc., work was begun July 27. August 12 work was suspended until September 1, awaiting a decision in regard to a proposed change in location of battery. Fortunately no change was made, but the lost time materially interfered with the work and continued it to so late a date in the autumn as to prevent the fertilizing and seeding of the parapet and ditch which the light nature of the soil and sod rendered necessary to a proper completion of the work. This was deferred until the spring and has now been satisfactorily done.

Guns and carriages were transported from Fort Warren by lighter and rail via Boston to East Greenwich, R. I., whence they were hauled to the ground, distant some 7 miles. Thorough investigation and invitation of bids showed this to be a safer and more economical method than transportation entirely by water.

Revetment walls of gun battery, magazine, and magazine approach are of coursed rubble granite with rock face. Coping is of same material. All stone and brick work above ground and 8 inches of top of foundation are laid in cement mortar composed of one part Rosendale cement, one-half part lime, and one and one-half parts clean, sharp sand. The approach to magazine door is by two flights of stone steps, one on either side of door. Floor of approach is paved with brick laid in cement mortar. A tile drain conducts water from floor of approach to a gully near by.

Magazine is of yellow pine situated partly above and partly below the ground level; contains filling and storage rooms connected by doors, and is provided with cast-iron ventilating pipes. Interior is sheathed throughout with 1 by 4 inch yellow-pine boards, planed on one side, tongued and grooved. Sides, rear end, and roof are covered with heavy tarred-felt paper, and roof has, in addition, a coat of asphalt. All timbers and planking used in construction of magazine and platforms received a coat of hot tar before laying. Roof was covered with 3 to 4 feet of earth and sides with 4 feet. Doors have brass locks and hinges on account of proximity of the salt water. Magazine approach is protected by wrought-iron fence securely let into the revetment wall.

Platforms are of yellow pine, laid in well-rammed excavations. On account of the loose, sandy nature of the soil stone foundations were not considered necessary.

Two flights of steps give access to mortar parapet, and smaller flights of steps communicate with the terreplein from the rear.

The ditch was constructed along the front of the work only, so as to give the requisite quantity of earth for the parapet, which is mainly on the ground level. Loam was removed from the top of soil and saved for partial covering of parapet. The parapet, bottom and faces of ditch and slope in rear of terreplein were carefully sodded and have since been fertilized and seeded, as well as a strip 2 feet wide around the edge of the ditch. It was not deemed best to peg the sod on account of its light nature.

The work is substantially constructed. All foundations are laid 48 inches below ground level, that for parapet wall being 22 inches wide and that for magazine wall 26 inches wide. On account of the nature of the soil slopes were made 1½ on 1.

Gun platforms were made and laid on the ground. Mortar platforms, magazine doors, and iron work for gun platforms were supplied from the Watertown Arsenal by your authority.

The total cost of the work was $4,675.82, of which $2,165.75 was for material (including $150.30 cost of mortar platforms), and $2,510.07 for labor and transportation.

Statement of material purchased, copies of specifications issued in advertising for the construction of work, and tracings Nos. 1 to 3 showing the details of construction are herewith.

Very respectfully,

FRANK BAKER,
Captain, Ordnance Department, U. S. A.

The CHIEF OF ORDNANCE, UNITED STATES ARMY
(Through Commanding Officer, Watertown Arsenal).

Statement of material purchased for construction of battery at Quonset Point, Rhode Island.

Ironmongery:	
2 bolts, bronze, foot, 8 inches, at $0.75	$1.50
2 bolts, bronze, chain, 8 inches, at $0.85	1.70
6 pairs butts, bronze, 5 by 5 inches, at $2	12.00
2 doorlatches, bronze, at $1.40	2.80
2 deadlocks, bronze, at $2.40	4.80
848 pounds iron bar, refd., 1 inch rd., at $0.018	15.26
960 pounds iron bar, refd., 53 by 53 by 1 inches, at $0.019	18.24
1,550 pounds iron plate, 14 by 6 by 1 inches, at $0.025	38.75
100 pounds nails, steel-wire, com. 10-penny, at $0.0275	2.75
200 pounds nails, steel-wire, com. 60-penny, at $0.0230	4.60
25 feet pipe, cast iron, heavy, 5 inches, at $0.60	15.00
300 pounds spikes, steel-wire, 9 inches, at $0.0336	10.08
100 pounds spikes, steel-wire, 9 inches, at $0.0325	3.25
5 pounds spikes, at $0.04	.20
4 ventilating caps, cast iron, 5 inches, at $0.75	3.00
Lumber and other building material:	
1,000 feet boards, yellow pine	37.00
40 barrels cement, Rosendale, at $1.10	44.00
167 feet coursed rubble granite, 1 by 2 feet, at $1.70	283.90
383 feet coursed rubble granite, 1 by 1 foot by 8 inches, at $1.49	570.67
62 feet coursed rubble granite, 9 inches by 1 foot by 4 inches, at $1.23	76.26
200 feet drainpipe, Akron, 4 inches, at $0.08	16.00
2 elbows, drainpipe, 4 inches, at $0.26	.52
137½ feet granite coping, at $1	137.50
12 granite steps, at $5.04	60.48
150 feet hard pine flooring, at $35 per thousand	5.25
9 barrels lime, at $0.93	8.37
7,684 feet plank, yellow pine, at $34 per thousand	261.26
572 feet plank, pine, 2 inches, at $30 per thousand	17.16
52 cubic yards stone foundation, at $0.45	23.40
92 pounds tarred paper, at $0.02	1.84
7,966 feet timber, yellow pine, at $34 per thousand	270.84
Paints, oils, dyes, and lacquers:	
4 gallons linseed oil, at $0.75	3.00
8 pounds metallic paint, at $0.03	.24
9½ pounds paint, bronze-green, at $0.13	1.23
1 gallon turpentine	.50
Miscellaneous articles:	
6 cubic yards loam, at $0.40	2.40
9,560 square feet sod, at $0.005	47.80
2 bushel lawn-grass mixture, at $2.35	4.70
300 pounds lawn dressing, at $2.40 per hundred weight	7.20
Total	2,015.45

(5681—Enc. 57)

SPECIFICATIONS UPON WHICH BIDS WERE INVITED FOR CONSTRUCTION OF BATTERY AT QUONSET POINT AND IN ACCORDANCE WITH PLANS OF MAJOR GREER.

[See Appendix 32, Report Chief of Ordnance, 1889. Plans were modified in battery as finally constructed.]

Specifications for the construction of a battery at the State Camp Ground, Quonset Point, Rhode Island.

For the excavation of the ditch and construction of the parapet and revetment, construction of the magazine and approaches thereto, construction and laying of gun platforms and mounting guns and carriages thereon, laying mortar platforms and mounting mortars and beds thereon.

The guns, carriages, mortars, mortar beds, and mortar platforms will be delivered by the United States on the battery site.

The parapet and ditch will be constructed in accordance with the blue prints herewith, the ground in rear of the parapet to be graded to a line parallel with the long face of parapet and for a distance of ten (10) feet in rear of magazine approach as shown, and such earth as it is necessary to remove may be used in construction of the parapet and the depth of the ditch may be proportionally reduced. A sufficient slope for drainage will be given to the ground from the parapet to the rear.

The earth to be compacted in the parapet by rolling with a heavy roller, as spread; all slopes of ditch, parapet, magazine cover, magazine approaches, and any slopes which may be made by necessary excavation in the construction of the work to be faced with loam to a depth of eight (8) inches and rammed. All slopes above designated, the bottom of the ditch, and a strip two feet around the outer edge of the ditch to be carefully sodded; sods to be two (2) inches thick, edges well driven together, thoroughly beaten or rolled down and pegged in slopes at intervals of two (2) feet, each sod to have at least one peg. After laying, the sod will be thoroughly watered each evening until the grass is well started.

The bottom of the ditch will be given sufficient slope for drainage and from the lowest point an eight-inch drainpipe will be laid so as to lead the water to a proper distance from the work.

Revetment wall of parapet, magazine, and magazine approach to be of coursed rubble granite margin dressed with rock face, beds and joints roughly dressed. Stone foundation twenty-two (22) inches wide, forty-eight (48) inches deep, laid dry for forty (40) inches and eight (8) inches on the top laid in cement mortar.

The whole to be capped with a granite coping made up of blocks one (1) foot eleven (11) inches wide by three (3) to six (6) inches thick, rough dressed, projecting three (3) inches over face of wall and laid as per drawing. The wall and coping, except as noted in the foundation, to be laid in cement mortar of three (3) parts Rosendale cement and one part lime.

Two flights of wooden steps two (2) feet six (6) inches wide are to be put up on the mortar battery as per blue print.

Magazine.—The magazine is to be built entirely of well-seasoned yellow pine, according to blue prints herewith. It consists of two rooms, viz, storage room 10 by 12 feet, and filling room 10 by 10 feet, each room being provided with two capped ventilating pipes of cast iron, 5 inches in diameter, having slides at the inner openings to permit closing and opening at will.

There are three bottom sills 8 by 8 inches, upon which rest the three cross sills, the front and middle beams 8 by 8 inches and the rear one 8 by 10 inches. The floor beams, of which there are sixteen, are 4 by 8 inches. The posts and studding to have tenons at top and bottom to fit mortises in sills. The side plates, end plates, and rafters are to be constructed as shown on blue print and tied by wrought-iron rods one (1) inch in diameter. The floor planks are 3 by 8 inches and the sides, ends, and roof have 4 by 8 inch planks.

There are two door openings to be provided with extra-heavy double doors two (2) feet by six (6) feet six (6) inches, well braced, and to have locks and keys and bolts. The entire interior to be sheathed with one (1) inch by four (4) inch yellow-pine boards, planed on one side, tongued and grooved. The sides, rear end, and roof to be covered with heavy tarred felt paper and roof to have, in addition, a coat of asphalt. The sills, floor beams, and under side of flooring to receive a thorough coating of hot tar.

All woodwork showing outside to receive a priming coat and two (2) coats of olive-green paint.

The approach to the magazine will be by two flights of stone steps of dimension and laid as shown, treads and risers to be two cut. The bottom of approach to be paved with hard paving brick. A five (5) inch drainpipe will be laid from the magazine entrance to the ditch.

The revetment wall of magazine approach to be surmounted by a wrought-iron fence as shown on drawing. Each post will be bedded with lead into the wall for a depth of about twelve (12) inches.

The gun platforms are to be of well-seasoned yellow pine and laid in accordance with the drawings herewith. All timbers and plankings must receive a coat of hot tar before laying. The ground to be excavated to the necessary depth and rammed. The top surface of platform to be seven (7) inches above the surface of the ground and earth graded so as to carry away the water. The top surfaces of the platforms must be true and level.

The beds for the mortar platform must be level and the ground well rammed. The bed must be deep enough to allow the upper surface of the platform to be slightly above the surrounding ground for drainage. The sleepers are laid parallel to the plane of fire three (3) on each side at equal distances apart so that the holes in their ends shall correspond to the holes in the front and rear deck planks. The front deck plank is laid first and the eyebolts driven in to secure it; the remaining planks are driven up against it and the last secured like the first with eyebolts. A securing stake is driven at the rear end of each sleeper. The earth on all sides should be raised nearly as high as the platform and well rammed, giving it a slight inclination outwards to allow the water to run off. The upper surface of the platform *must* be level and true.

The guns and mortars after mounting are to be covered with a coat of black lacquer. The gun carriages and mortar beds, after mounting, will be thoroughly scraped and then have a coat of red metallic paint.

Each bidder will state the length of time which he will require for the completion of the work. The Government reserves the right to reject any or all bids.

LUMBER REQUIRED FOR MAGAZINE.

Number.	Name.	Dimensions.	Mark.
3	Sills (longitudinal)	8 by 8 inches, 25 feet 2 inches long	A.
2	Sills (cross) front and middle	8 by 8 inches, 11 feet 6 inches long	B.
1	Sill (cross) rear	8 by 10 inches, 11 feet 6 inches long	C.
4	End posts, front and middle corners	8 by 8 inches, 6 feet 9 inches long	D.
2	End posts (rear) corners	8 by 8 inches, 6 feet 7 inches long	E.
1	End post (rear) middle	8 by 10 inches, 8 feet long	F.
4	Door posts	8 by 8 inches, 7 feet 9 inches long	G.
1	End plate (rear)	8 by 10 inches, 11 feet 6 inches long	H.
2	Plates (side)	8 by 8 inches, 24 feet 6 inches long	I.
2	End rafters (rear)	8 by 10 inches, 5 feet 11 inches long	K.
4	End and middle rafters	8 by 8 inches, 5 feet 11 inches long	L.
4	End and middle plates	6 by 8 inches, 3 feet 4 inches long	M.
2	Door sills	6 by 8 inches, 4 feet 8 inches long	N.
16	Floor beams	4 by 8 inches, 11 feet 6 inches long	O.
23	Studdings (side)	4 by 8 inches, 7 feet 6 inches long	P.
6	Studdings (rear end)	4 by 10 inches, 6 feet 7 inches long	R.
4	Studdings (doors)	4 by 8 inches, 6 feet 5 inches long	S.
1	Short studding (rear end)	4 by 10 inches, 4 feet long	T.
1	Short studding (front and middle)	4 by 8 inches, 2 feet long	U.
1	Ridge	3 by 8 inches, 24 feet 6 inches long	V.
15	Floor planks	3 by 8 inches, 12 feet long	
9	.....do	3 by 8 inches, 10 feet long	
6	.....do	3 by 8 inches, 12 feet 2 inches long between doors.	
24	Side planks	4 by 8 inches, 24 feet 6 inches long	
16	End planking (rear)	4 by 8 inches, 12 feet 2 inches long	
24	End planking (front)	4 by 8 inches, 4 feet long	
20	Roof planking	4 by 8 inches, 24 feet 2 inches long	
2	Caps for ends	3 by 10 inches, 6 feet 8 inches long	
36	Rafters (12 inches between centers)	4 by 8 inches, 5 feet 11 inches long	
[a]230	Square feet, floor, upper	1 inch thick (*b*)	
[a]770	Square feet, sides and roof	1 inch thick (*b*)	

[a] Should be 1,150.

[b] Tongued and grooved.

LUMBER REQUIRED FOR PLATFORM FOR 10-INCH RODMAN S. B. GUN, YELLOW PINE.

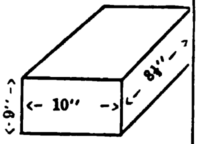
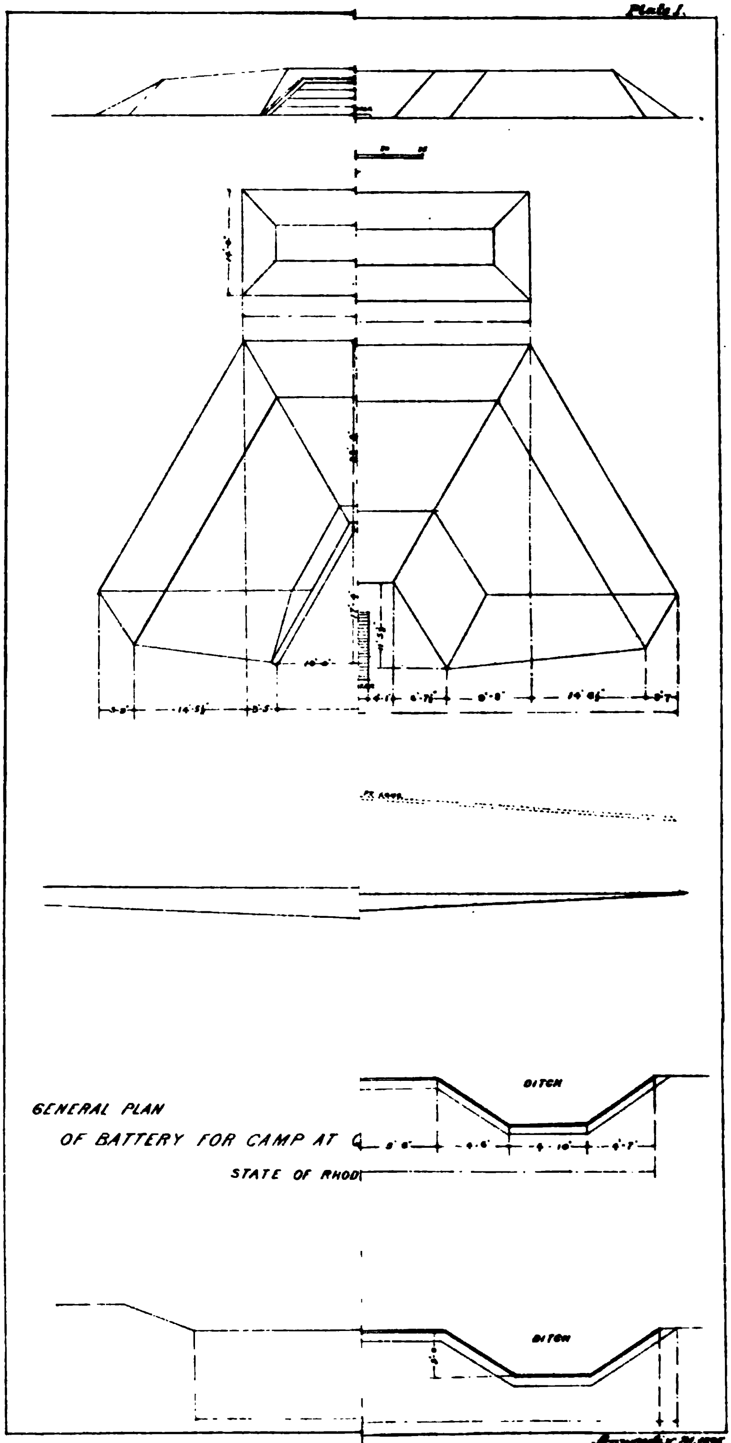
Number.	Name.	Dimensions.	Mark.	
12	Traverse circle support	6 by 12 inches by 15 feet	A 1.	
18	Flooring	4 by 12 inches by 15 feet	B 1.	
16	.....do	4 by 12 inches by 5 feet 3½ inches.	C 1.	
2	Pintle plate support	4 by 10 inches by 4 feet 5 inches.	D 1.	
6	Pintle support	12 by 14 inches by 4 feet 5 inches.	E 1.	
2	.....do	10 by 14 inches by 4 feet 5 inches.	F 1.	
4	Filling blocks	8½ by 9 by 10 inches	G 1.	
6	Pintle supports	12 by 12 inches by 15 feet	H 1.	
6	Pintle posts	10 by 12 inches by 12 feet	K 1.	
12	End posts	8 by 8 inches by 8 feet 6 inches.	L 1.	
2	End cross guides	8 by 12 inches by 15 feet	M 1.	
4	Longitudinal sills	8 by 12 inches by 15 feet 4 inches.	N 1.	
4	.....do	12 by 12 inches by 15 feet 4 inches.	O 1.	
4	.....do	12 by 12 inches by 19 feet	P 1.	

Plate I.



Appendix 31.1836

Ord 54 2

POINT

ODE ISL

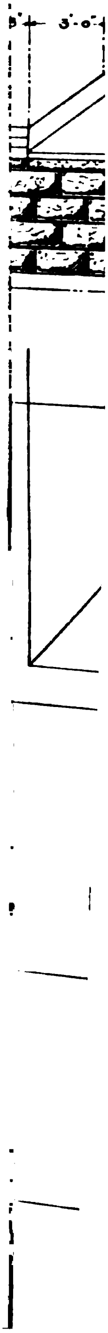
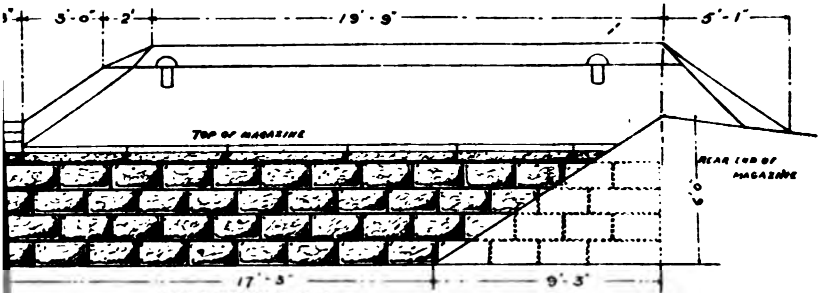


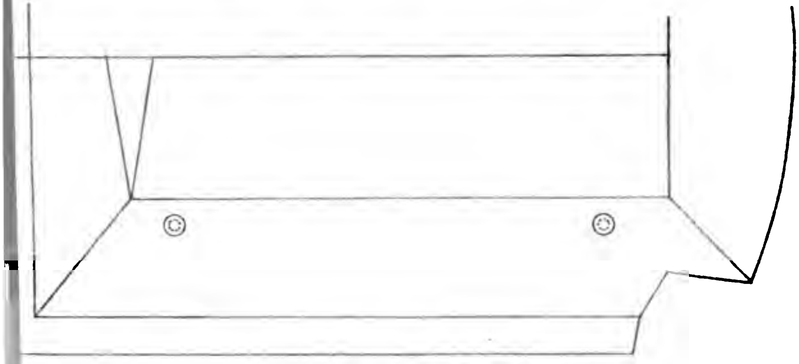
Plate II.

POINT

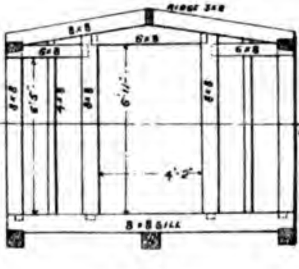
ODE ISLAND.



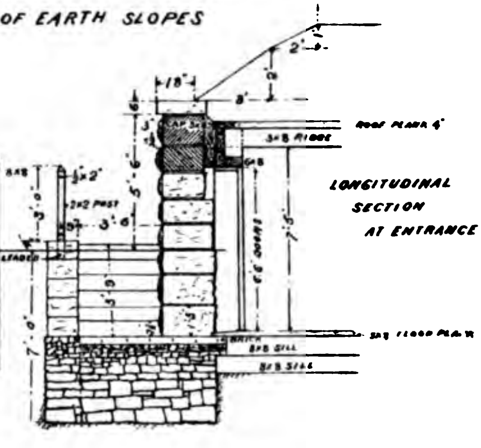
SIDE ELEVATION



PLAN OF EARTH SLOPES



FRAMING FRONT

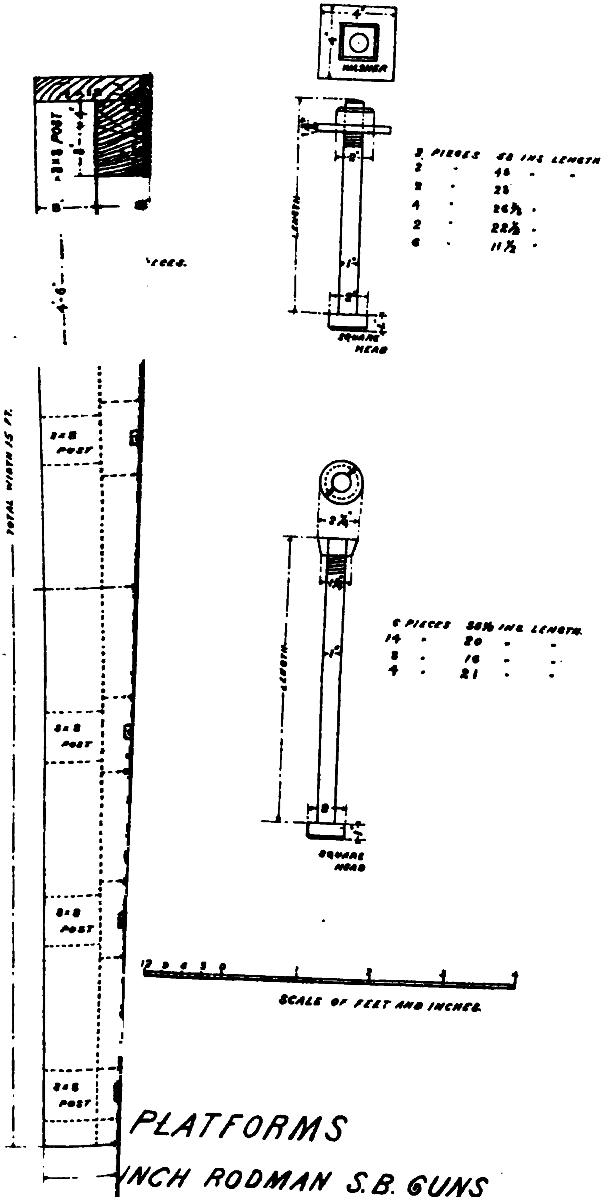


LONGITUDINAL SECTION AT ENTRANCE

Appendix 31, 1896

Ord 54 2

Plate III.



PLATFORMS

INCH RODMAN S.B. GUNS

ERY FOR CAMP AT QUONSET POINT

STATE OF RHODE ISLAND.

Appendix 31, 1896.

Ord 54 2

APPENDIX 32.

REPORT OF BOARD FOR INSPECTING AND TESTING THE PNEUMATIC DYNAMITE GUN BATTERY AND PLANT NEAR FORT WINFIELD SCOTT, CAL.

BENICIA ARSENAL, CAL., *December 19, 1895.*

The board was constituted by Special Orders, No. 240, Headquarters of the Army, Adjutant-General's Office, dated October 14, 1895, "for the purpose of ascertaining whether the guns, carriages, appliances, etc., soon to be ready for trial at the Presidio of San Francisco, Cal., fulfill the requirements specified in the contract dated January 27, 1893, between the United States and the Pneumatic Torpedo and Construction Company."

The date of completion of the contract, after being extended several times, was finally fixed at December 27, 1895.

The contract calls for the erection at Fort Winfield Scott, Cal., of one group of three 15-inch pneumatic dynamite guns of 40 calibers length of bore, "with their carriages and projectiles and the necessary machinery, appurtenances, and accessories, properly and securely placed, to fire, operate, or handle the same, all complete and mounted in place ready for military use. The guns and carriages to be supplied with secure and adequate foundations so as to stand without any derangement, the continuous fire of the heaviest projectiles to be used in these guns."

For the purpose of the tests there were to be furnished 11 projectiles (3 shell charged with 500, and 8 shell charged with 100 pounds of explosive gelatin), also 15 dummy projectiles of full caliber and weight. There were also to be furnished in addition for each gun two 15-inch shell adapted to a charge of 100 pounds of explosive gelatin, five adapted to a charge of 200 pounds, and three adapted to a charge of 500 pounds.

The board was notified that the guns and plant would be ready for test on December 4, 1895, and the tests were begun on that day, continuing as the weather permitted until December 9.

The three guns are mounted on the bluffs behind Fort Winfield Scott in a line facing the entrance to the harbor of San Francisco, and at a distance of about 3 miles from the entrance. They are placed 226 feet from the edge of the bluff, and the left gun has an elevation of 285 feet above the sea level. The guns are 83 feet apart, each gun being on a level 2 feet lower than the one on its left. This difference of level is for the purpose of allowing the air reservoirs of each gun to be conveniently disposed in the underground vaults that lie between the guns, and outside the outer guns.

The power house stands 150 feet in rear of the center of the battery. The house is 106 feet long by 50 feet wide, built of brick, with walls 13 inches thick. The boilers are in the southern end of the building in a room 38 feet 6 inches long and extending the width of the building.

The boilers are erected in double setting, one in each setting with a dividing wall between. A passage runs between the two settings to the door of the engine room. The door is in a 13-inch brick wall dividing the two rooms. The engine room containing the compressors, the steam fans, and the dynamo and its engine is 48 feet 10 inches long and extends the width of the building. The engines are erected on concrete foundations. The foundations of the compressors form the walls of concrete tanks under the floor. The intercoolers are set in the tanks which are filled with water during the operation of the engines. At the north end of the building and separated from the engine room by a wooden partition is a room 15 feet by 37 feet 5 inches, containing the distributing manifold and gauges and the air-storage tanks. An office 12 feet by 10 feet opens off this room and contains table and chairs and a stationary washstand and locker. A small storeroom 8 feet 7 inches by 10 feet, provided with shelves, opens off the engine room.

A frame storehouse 20 by 25 feet, in which the projectiles were kept and charged, is built to the left and rear of the battery. Two heavy iron beams about 7 feet above the floor form a runway for hoisting pulleys by means of which the charged projectiles are carried outside of the building and loaded on the loading carriages. A plank road 12 feet wide extends from the storehouse along the rear of the battery. Immediately in front of the house the road has a width of 15 feet and as it approaches each gun platform it widens to 22 feet 1 inch. A board walk 5 feet wide runs from the plank road to the door of the power house.

GUNS AND CARRIAGES.

The guns and carriages are of precisely the same pattern and differ in no particular from those delivered at Sandy Hook, N. J., and described in the report of the Chief of Ordnance for 1894.

The projectiles and fuses are likewise similar in every respect to those there described.

Further description of these parts of the system is therefore omitted here.

THE EXPLOSIVE.

The explosive gelatin used in the projectiles was manufactured by the Giant Powder Company of San Francisco. Its composition was as follows:

87 per cent nitroglycerin.
7 per cent gun cotton.
4 per cent camphor.
2 per cent carbonate of magnesia.

The average weight of explosive, exclusive of the paper boxes in which it was loaded into the shell, was 97.225 pounds in each 8-inch subcaliber shell, and 514.273 pounds in each full-caliber shell. To these must be added 2.6 pounds dry gun cotton contained in the primer.

The explosion of 100 pounds of gelatin on impact with the water threw up a column of water about 300 feet high, and the explosion of 500 pounds threw up a column considerably higher.

The detonators contained 35 grains fulminate of mercury.

THE AIR COMPRESSORS.

The air-compressing plant was built by the Fulton Engineering and Ship-Building Works of San Francisco, after the designs furnished by Mr. Edward A. Rix, of the same place.

The compressors consist of two independent duplex machines. Each duplex machine consists of two high-pressure steam cylinders 20 inches in diameter by 24 inches stroke, controlled by a Meyers cut-off expansion device. The shaft is 10 inches in diameter. The crank pins are 6 inches in diameter. The flywheel is 12 feet in diameter, weighing 13,000 pounds. The piston rods are 4½ inches in diameter at the steam end. The bed of the engine is of the Corliss type, having a very heavy, reinforced, girder frame. The main bearings are adjusted by wedges, the pillow-block cap being screwed solid to the pillow block. The valve motion is actuated by four eccentrics, working rocker arms instead of the slide blocks as in the ordinary way. The steam cylinders are thoroughly jacketed with nonconducting covering.

Tandem to the steam cylinders are the initial air cylinders, connected thereto by frames of a truncated, conical type, open at the sides. The initial air cylinders are two in number, 13 inches in diameter by 24-inch stroke, having poppet inlet valves of the Brenner type. These inlet valves have neither bolts, nuts, nor screws of any kind, and the air passes into the cylinder through their center. The outlet valves are of the ordinary poppet type.

The initial cylinders are double acting. They are of the water jacketed type, having about 10 longitudinal compartments through which the water flows from two independent sources. The heads are also jacketed and receive the outflowing water from the cylinders. The highest temperature of the air discharged from these cylinders was 320°.

Immediately tandem to the initial cylinders and connected thereto by another truncated, conical frame, is on one side the intermediate cylinder and on the other side the high-pressure cylinder. The intermediate cylinder is of the jacketed type, divided into two independent circulations of several compartments to each circulation. The water is introduced independently to these two circulations and discharged independently from them. There is also an independent water circulation for the spherical head, which surrounds the valves and keeps them cool. The discharge temperature of the air from this cylinder did not exceed 292°. The ram of the intermediate cylinder is 10 inches in diameter by 24-inch stroke and has a spherical end which projects into the cylinder head of a similar shape, in which are placed two valves, one an inlet valve and one an outlet valve. The reason for making the heads of spherical shape is to give an opportunity to put in valves of large opening, the valves being placed at an angle of 45° to the axis of the cylinder. The ram is of cast iron and is hollow inside, divided into two compartments. The circulating water, entering at one side, passes to the front end of the ram back through the other compartment and out at the other side. The water is enabled to pass readily through the moving ram by means of small brass plungers which follow the motion of the machine through inclosing pipes and stuffing boxes. The ram is packed with about thirty rings of packing ¼ inch thick, 2 inches wide, and of sufficient diameter to encircle it. The rings are cut from canvas belt and boiled in oil and plumbago. This makes a perfect packing, which never has been disturbed from the beginning to the end of the test. The circulating water through the center of the ram maintains it cool under the friction pressure created by the packing.

The high-pressure cylinder is of a similar construction to the intermediate cylinder, with the exception that it is bored to receive a bronze liner ⅝ inch thick, which had been tested to 3,000 pounds hydraulic pressure and found to be perfect. Within the bronze liner operates a wrought steel plunger which is bored out to within 2 inches of its length to receive the water circulation, entirely similar to the one described in the intermediate ram. The cylinder heads are also spherical and made of bronze, the valves being of steel operated on bronze seats. The idea of steel on bronze being first to prevent rust between the valve and the seat contact whenever the machine is idle, and secondly, under the temperatures bronze has more of an expansion and does not bind the valve on its seat. The intermediate cylinder valves are of the same nature.

The packing in the high-pressure ram is metallic, consisting of alternate wedges of brass and babbitt, the babbitt resting upon the ram and the brass upon the outer surface of the stuffing box; the brass wedges being used to push forward the babbitt. This packing acts very satisfactorily and has never been disturbed from the time the machine was started.

The highest discharge temperature from the high-pressure cylinder was 358°. It will be noted that the temperature of adiabatic compression to 2,000 pounds, is 1,762°. The total temperature for the three compressions is 970°, showing that the efficiency of the cooling system, together with the three stage compression, gives the general efficiency as 970 is to 1,762.

This naturally leads to a consideration of the intercoolers used in this system of compression. These intercoolers are located within the foundations, being in three pits which are connected together, the pits being approximately 5 feet wide, 4 feet deep, and 18 feet long each. The air leaving the initial cylinders passes into the initial intercoolers, which consist of 35 copper tubes of No. 18 copper, 1 inch outside diameter and 18 feet long. These tubes are secured to manifolds, by means of ordinary stuffing glands at the ends, and are supported at the centers by means of a diaphragm punched to receive them.

From this intercooler the air passes into the intermediate cylinder. From the intermediate cylinder it passes into an intercooler of entirely similar construction, having 20 copper tubes, 18 feet long, 1 inch outside diameter, with an inside diameter of ¾ inch. These are secured to manifolds and supported in a manner entirely similar to that described in the initial intercoolers. From this intercooler the air passes to the high-pressure cylinder. After being compressed to 2,000 pounds, the air passes from the high-pressure cylinder to an intercooler consisting of 10 copper tubes, 18 feet long, secured to the manifolds by stuffing boxes, the same as the others.

The air from these final intercoolers passes through double, extra heavy, wrought-iron pipe, 1⅝ inches in diameter (inside), and 2½ inches outside diameter, to the firing or distributing manifold, and thence to the reservoirs.

There are 24 storage reservoirs, 24 feet 3 inches long, 14⅜ inside diameter, and 16 inches outside diameter. Capacity of each tube, 27.33 cubic feet, making a total of 655.92 cubic feet. The reservoirs are placed in six vertical rows, four in a row, and each double row of eight tubes is connected by ⅝-inch copper tubing to a bronze manifold, which manifold is in turn connected at the bottom by 2½-inch double, extra heavy pipe to its own valve on the distributing manifold. Each battery of eight tubes thus forms an independent reservoir, and air may be drawn from any one or from the three batteries at pleasure. Each cylinder is provided with a drain cock.

The distributing manifold is also connected with each gun independently by 2½-inch double, extra-heavy pipe, having inside diameter of 1⅝ inches. This is laid in a trough underneath the ground and leads to the storage system of the gun, which includes eight tubes similar to those described except that their interior diameters are 14¾ inches, laid four on each side of the gun in underground vaults. Alongside of each pipe is a ¼-inch inside diameter copper tube leading back from the storage system of the gun to a pressure gauge placed on the distributing manifold over the corresponding valve. The pipes, gauge tubes, and double conductor cable are all practically the same length, being about 800 feet.

The pressures maintained throughout this system during the tests were about as follows: In the steam cylinders, 90 pounds; in the initial air cylinders, 72 pounds; in the intermediate air cylinders, 370 pounds; in the high-pressure cylinders and storage tanks, 2,000 pounds. The indicated horsepower was 293.78 for each compressor and the indicated horsepower on the engines was 342.61 for each compressor, the difference, 48.83 horsepower, being the work absorbed by friction in cylinders, in stuffing boxes and bearings throughout the machine, giving the compressors a mechanical efficiency of 85.8 per cent.

The intake temperatures of the air throughout the whole performance did not exceed the temperature of the cooling water more than 5°, showing the intercoolers were amply sufficient for the work.

The compressors, running at 100 revolutions per minute, delivered to the receivers 457.2 cubic feet of air per hour, at 2,000 pounds. The action of the compressors throughout was smooth, no water being used upon any of the piston rods or any of the bearings during the test.

THE BOILERS.

The steam for actuating the compressors was furnished by four horizontal tubular boilers, 72 inches in diameter by 16 feet long, of the tubular type. Each boiler is fitted with a steam drum 32 inches in diameter and 32 inches high. The boilers are constructed of open-hearth homogeneous flanged-steel plate of 60,000 pounds tensile strength; shells ⅜ inch thick, heads ½ inch. Each boiler is fitted with eighty-two 4-inch lap welded tubes, 16 feet long, set in vertical and horizontal rows. All vertical or girth seams are single riveted and all horizontal or longitudinal seams are double riveted.

The main heads of the boilers are thoroughly and well braced to the shell. Each boiler is fitted with manhole at the back end over the tubes and in the front end over the crown sheet. Each boiler has three heavy cast-iron brackets riveted to the shell, for supporting the boiler in the setting, and has proper bolts and rollers for the same to rest upon. Each boiler has a full flush fire front, provided with fire doors. Grate bars are furnished for forced draft. The smokestacks are short, 48 inches in diameter and 15 feet long, and they connect to Y breechings rising from above the full flush front. The stacks pierce the roof through roof plates, and umbrellas are furnished over the stacks, and the necessary guy ropes are provided to sustain them in position.

Each boiler is furnished with safety valves, steam gauge, and siphon, water gauge, steam pipe, three gauge cocks, check valve, stop valve for feed water, and blow-off cock.

The boilers were tested to 150 pounds hydrostatic pressure after being in place, and were tight. They are erected in brick settings, 22 inches thick, with 4-inch air space. The boilers have, in addition to the hydrostatic pressure, been tested to 125 pounds live steam pressure.

Underneath the boiler foundations and connecting to two independent Sturtevant steam fans is a 22-inch conduit, provided with suitable dampers and having under the center of each boiler a 10-inch outlet connected to each ash pit.

The two Sturtevant steam fans are located in the engine room, each capable of delivering 13,000 cubic feet per minute of air to the gauge. As shown in the test, these fans were amply sufficient to furnish draft for the bituminous coal which was used. The Sturtevant fans have engines 3 by 4½ inches.

The boilers are fed by two Dean duplex boiler feed pumps, capable of pumping 100 gallons per minute. Steam cylinders 6 inches in diameter, water cylinders 4 inches in diameter and 6-inch stroke, also reinforced by two Nathan injectors, of 300 horsepower each, connected to the feed piping, so that they may be utilized in case anything should happen to the pumps.

The feed water is heated by two national feed-water heaters, of 350 horsepower each, which are placed immediately behind the engines and connect to the exhausts in such a manner that either or both of the heaters can be used with either engine. The tops of these heaters are connected to the atmosphere.

THE ELECTRIC PLANT.

For the electric plant there is installed a 9½ by 10 inch Armington & Sims high-speed engine, erected on foundations, with all steam and exhaust and return pipes complete. This engine is belted directly to a dynamo manufactured by the Electrical Engineering Company of San Francisco, having a capacity of 35 kilowatts, and supplying a current with an electro-motive force of 125 volts. The dynamo is compound wound and is subtantially the same as used for direct current incandescent lighting. The bearings of this dynamo are self-oiling and the brushes are held upon the commutator by suitable springs.

Upon the wall of the engine room, within about 5 feet of the dynamo, is placed a polished slate switch board, provided with an ammeter graduated from 0 to 500 amperes and a volt meter reading from 0 to 150 volts. There are also three double-pole 300-ampere knife switches and six suitable fusible plugs. The switch board is connected to the dynamo by insulated wire, supported on porcelain insulators, the wire having cross section to carry a current of 300 amperes for five minutes, without overheating. The switch board is connected to each gun by double-conductor lead-covered cables leading underneath the ground, there being about 800 feet of this cable in all.

THE COMPRESSOR ENGINES.

Steam engine.—At actual work it was found that with a boiler pressure of 100 pounds the cut-off was set at one-fourth to do the entire work, which made the engines economical in their operation.

Each of the engines is fitted with a governor. This governor does not regulate the speed of the engine, for in order to obtain the most economical use of the steam it was deemed advisable to run the engines by the cut-off and to utilize the governor only in case of excessive speed. The governors are so adjusted that when a speed of about 125 revolutions is attained a butterfly is released, which shuts off the steam in the main steam pipe.

In the engine room there is a gauge board, having one steam gauge to register the boiler pressure, two gauges to register the initial air pressures, two gauges to register the intermediate air pressures, and one gauge to register the high pressure.

THE TESTS.

As the duty of the board was to ascertain whether the guns, carriages, appliances, etc., fulfilled the requirements specified in the contract, each of the specifications accompanying the contract will now be considered. These are the amended specifications of December 15, 1894.

SPECIFICATION 1.

The three pneumatic dynamite guns of 15-inch caliber, including the necessary machinery to fire and handle the same, ammunition and carriages for the same, must be placed and mounted ready for military use at the place designated in the advertisement of April 23, 1889.

The advertisement called for the mounting of the three guns and carriages at Fort Winfield Scott, Cal.

SPECIFICATION 2.

The guns shall be 40 calibers length of bore, to be fully equal in quality of material, finish of parts, and performance, and subject to like tests as guns of the same caliber and length of bore now being procured or that have been delivered under contract. The gun carriages and machinery to be mounted upon secure and adequate foundations which shall be sufficient to withstand, without any derangement, a continuous fire of the heaviest projectiles to be used in the guns.

The guns are precisely similar to those that have already been delivered under contract at Sandy Hook, N. J. The foundations have suffered no injury, nor developed any weakness during the tests, and appear to be secure and adequate.

SPECIFICATION 3.

The plant of the three guns to comprise a suitable complement of boilers, air-compressors, storage reservoirs, and hydraulic pumps to give capacity for a continuous fire for extreme range of forty-five rounds for the first hour and thirty rounds per hour thereafter, such capacity to be satisfactorily established by actual tests; the boilers and compressors included in such plant to be in duplicate, each to supply one-half the required capacity. The connections to be so arranged as to give capacity for a continuous fire of thirty rounds for the first hour and twenty rounds per hour thereafter if only two of the guns be used, and twenty rounds for the first hour and ten rounds per hour thereafter if but one of the guns be used.

The test for capacity of the compressors developed the fact that they are fully capable of supplying air to the guns in sufficient quantity for firing forty-five rounds per hour at extreme range continuously. In the table of the test, which follows in the summary, it will be noted that fifty-four rounds (air shots only) were fired. As in the first nine rounds the loss of pressure was not considered sufficient to produce extreme range, these rounds were thrown out and the test includes only the remaining forty-five, numbered from 10 to 54. These rounds were fired in 52½ minutes. At the beginning of the test the pressure per square inch in each gun was 1,000 pounds, and in the storage reservoirs 2,000 pounds. Through the first part of the test the compressors had no difficulty in keeping this pressure in the reservoirs, the engines running under 87 pounds of steam only. The last twenty rounds, numbered from 34 to 54, were fired at minute intervals, and though no effort was made to keep up the storage pressure, it had only fallen to 1,780 pounds at the fifty-fourth round. By reason of the surplus capacity developed in the first hour, the test for thirty rounds in the second hour was considered unnecessary and was not made.

Using one gun, twenty rounds, air shots, were fired in 7½ minutes, the pressure in the storage tanks falling from 1,780 to 1,280 pounds, the engines working under 93 pounds of steam.

That the loss of air was sufficient to produce extreme range was shown in the accuracy test, in which gun No. 3, using the same loss of air as in this test, produces a range of over 5,000 yards.

The other requirements of the specifications are complied with.

SPECIFICATION 4.

The boilers to be of a character to pass the usual Government inspection; the compressors to be capable of giving at least the requisite number of cubic feet capacity per hour at 1,000 pounds pressure per square inch and a proportionate volume at a pressure of 2,000 pounds per square inch, and to be tested for strength at 3,000 pounds per square inch. The storage reservoirs and connecting pipes and valves to be subjected to a test, by hydraulic pressure, of 2,500 pounds per square inch, and the gun valves and firing reservoir to a similar test of 1,800 pounds per square inch.

The boilers were subjected to the usual Government inspection. They were tested at 150 pounds hydraulic pressure and pronounced safe to carry 100 pounds of steam pressure.

The capacity of the compressors running at 100 revolutions per minute is 457.2 cubic feet of air per hour at 2,000 pounds pressure, or twice that much at 1,000 pounds. A four-hour test of the compressors running at this rate was witnessed by Lieutenant Lissak, Ordnance Department, inspector. All parts of the compressors that in operation sustain a pressure of 1,000 pounds were subjected by him to a pressure of 2,000 pounds, and those parts that sustain 2,000 pounds pressure were tested by pressure of 3,000 pounds.

SPECIFICATION 5.

The gun carriages to be center pintle, to admit of traversing through * * * 360° * * * and of elevating to + 35°; to be trained and elevated by pneumatic or hydraulic or, alternatively, by electric power directly under control of the gunner, and admit also of the same movement by hand power when required. The range of projectile to be controllable by variations of the pressures, elevations, or setting valves, singly or combined. The valve or firing device to be automatic and adjustable in its opening and closing, so that the loss of air may be readily controlled. The breech mechanism to be so arranged that the gun can not be discharged unless the breech is completely closed and locked. The loading apparatus to be of such character as to permit of a rate of firing at least once in three minutes for each gun, and a projectile charged with 500 pounds of the explosive, and twice that rate of speed for a projectile charged with 100 pounds of the explosive.

The traversing and elevating of the gun is done by electric power, and provision is made for the accomplishment of this work by hand when required.

The other requirements of the specification are complied with.

SPECIFICATION 6.

The shell to be of such character as to insure a uniform and steady flight, and not break up in the air or be mechanically destroyed on impact with water before detonation of the charge; to be provided with suitable electric contact fuses, which shall be safe in handling and certain of action; to admit of igniting the charge at any desired point, and also of igniting the charge at a number of points, to insure an explosion of the first order with the heavier charges; to be provided also with an electric immersion fuse, which shall be capable of ignition by immersion in salt or fresh water, and admit of fully controlling the time intervening between the entrance of the shell into the water and the explosion of the charge. Or, alternatively, to be provided with a suitable mechanical fuse which shall be safe in handling and certain of action, at all ranges, on impact with water or a more resistant object, and insure an explosion of the first order with all charges; also to be so arranged as to admit of fully controlling the time intervening between the entrance of the shell into the water and the explosion of the charge. The shell to be charged with the best quality of explosive gelatin or an equivalent bulk of other high explosive, with proper provision made to insure safety in handling and when loading and firing the guns.

The flight of the 8-inch subcaliber shell, charged with 100 pounds of explosive, was steady and uniform. The full-caliber 15-inch shell, charged with 500 pounds of explosive, were very unsteady in flight. The projectile had a gyrating motion, the tail revolving in a large circle about the line of flight, the head in a small circle. It was difficult to observe whether these shell always struck the water point first. There was no failure, however, to fire the fuse and explode the shell.

None of the projectiles broke in the air, and none appeared to break on striking before the detonation of the charge.

The fuses were mechanical and were set for instantaneous action or for delays of half a second or 2 seconds. Those set for action on impact worked as desired. A half second delay is so short that it was impossible to observe it. Two shells were fired with fuses set for 2 seconds' delay. One of these fell at such a range that the length of delay could not be obtained, though a delay was observed. The other fell at short range and a delay of 2 seconds was observed.

SPECIFICATION 7.

The unloaded shell required to be supplied must be provided with the full complement of fuses herein stipulated and be in complete order for use without other preparation than the insertion of the charge.

Of the thirty unloaded shell specified in the contract only twelve have been delivered here. These are 15-inch shell adapted to a charge of 200 pounds of explosive. Three fuses of 3 seconds' delay, three of 4 seconds, and one of 2 seconds have been delivered; also thirty-one dry gun cotton primers and thirty fulminate of mercury detonators.

SPECIFICATION 8.

Each gun, when finally mounted, to be fired six proof rounds, of which one shall be with shell containing the maximum charge of the explosive, and five with a suitable iron plug or dummy projectile, of full caliber and weight, to test the uniformity of action of the valve mechanism and other working parts, as well as to verify the rate of rapidity of firing and loading; and one or all of the guns, as the Department may elect, to be subjected to firing test for range, accuracy of fire, and action of projectile and fuse, for which purpose the contractor must supply not less than eight projectiles adapted to and containing a charge of 100 pounds explosive gelatin.

Thirty projectiles in all were fired from the three guns. Of these there were fired from each gun five dummies, one weighted shell, one shell containing 100 pounds of explosive, and one containing 500 pounds. In addition there were fired from gun No. 3 one weighted shell and five containing 100 pounds of explosive. The valve mechanism and all the working parts of the system acted in a most satisfactory manner throughout. Five dummy projectiles were used in the test for rapidity of firing and loading. Four shell charged with 100 pounds of explosive were used in the test for accuracy. The other projectiles served for tests for range, flight of projectile, etc.

SPECIFICATION 9.

The proof and other trials of the guns and appurtenances herein stipulated must be made at the expense of the contractors, who will furnish all the charged and the dummy projectiles or iron plugs required therefor, to be delivered free of cost to the United States at Fort Winfield Scott, California.

This specification was complied with.

SPECIFICATION 10.

It is further stipulated that the guns shall be fully equal in range and accuracy to those of the same caliber and length of bore now being procured or that have been delivered under contract: *Provided*, Therefore, it be fully established to the satisfaction of the Department that the three guns herein specified are in all material respects equal in efficiency to the said guns now under contract or delivered; then, so far as may be necessary, in the absence of direct tests, the performance of these guns shall be judged by that of the said guns now under contract or delivered.

The guns appear, as far as may be judged from the limited tests, to be fully equal in range and accuracy and in all material respects equal in efficiency to those delivered at Sandy Hook, N. J., as reported upon in the Report of the Chief of Ordnance for 1894.

SPECIFICATION 11

Each 15-inch gun of 40 calibers length of bore must be capable of projecting shell to the following ranges, with the charges of explosives noted, namely:

From 100 to 2,000 yards, a shell containing 500 pounds of the explosive.
From 100 to 3,550 yards, a shell containing 200 pounds of the explosive.
From 100 to 4,500 yards, a shell containing 100 pounds of the explosive.
From 100 to 5,000 yards, a shell containing 50 pounds of the explosive.

Provided, That if the guns do not attain the extreme ranges stated, forfeitures shall be imposed for each yard of deficiency in ranges as follows: With 500 pounds charge, five dollars; with 200 pounds charge, two dollars; with 100 pounds charge, one dollar; with 50 pounds charge, fifty cents: *And provided further*, That the limit of deficiency shall not exceed 10 per centum of the stated ranges.

Shells charged with 100 and 500 pounds of explosive were fired for range. The maximum range attained by a shell charged with 100 pounds was 5,070 yards and by a shell charged with 500 pounds 2,170 yards.

SPECIFICATION 12.

The accuracy for all guns must not fall below that indicated in the accompanying diagram marked A; the percentage of hits, at all ranges, in a rectangle 360 feet in length by 90 feet in width, to be at least equal to that indicated on the diagram.

The only test for accuracy that the supply of projectiles permitted was made with four shell charged with 100 pounds of explosive. The shell attained a mean range of 5,031¼ yards, a mean dispersion in range of 23¾ yards, and an extreme dispersion of 70 yards. Using the line from the piece through the center of impact as the line of fire, the mean deviation from that line was 16 yards, the extreme deviation from the line was 32 yards to the left, and the extreme lateral dispersion was 52 yards.

Diagram A calls for 34 per cent of hits in a rectangle 360 by 90 feet at a range of 5,030 yards. In the actual test 75 per cent of the shots fell within this rectangle, and a rectangle of 210 by 156 feet would contain them all.

Two shell charged with 100 pounds of explosive were fired from different guns on different days at a hillside about 3,700 yards distant across the harbor entrance. These shell struck 61 feet apart.

It is of interest to know that the craters formed in the soft red rock by the explosion of the shells were bowl-shaped, 25 feet in diameter, and 4 feet deep in one case, and 30 feet in diameter and 6 feet deep in the other. The shells were provided with impact fuses.

SPECIFICATION 13.

Seventy-five per centum of the charged shell fired for explosion on impact must show a satisfactory action of the impact fuses, and at least seventy-five per centum of such shells fired into water must show a satisfactory action of the immersion fuses adjusted for either the time or the depth of immersion.

All shell fired for impact showed satisfactory action of the fuses. As before stated, it was impossible to observe the delay in the fuses set for half a second, and of those set for 2 seconds, one observed delay was 2 seconds while the other was not obtained.

SPECIFICATION 14.

The time required to load and fire one shell containing 500 pounds of the explosive or a dummy projectile of equal weight must not exceed three minutes, and ten consecutive rounds of similar shell must be fired within forty minutes; for a shell containing 200 pounds of the explosive, or its equivalent weight, one in two minutes and ten consecutive rounds in twenty-seven minutes; for a shell containing smaller charges of the explosive, or its equivalent weight, one in 1¼ minutes and ten consecutive rounds in twenty minutes.

In the tests for rapidity of loading and firing, five dummies, representing shell containing 500 pounds of explosive, were fired in 8 minutes and 23 seconds, the longest interval elapsing between any two shots being 2 minutes. The time of loading the lighter shell was not taken. While the time required for loading live shell would undoubtedly be greater than when dummies are used, on account of the necessity of more accurately adjusting the elevation of the piece in order that the wings of the projectile may readily enter the bore, the time specified is so much greater than that actually occupied by the test that there can be no doubt but that live shell could be loaded in a time well within the requirements of the specification.

SPECIFICATION 15.

The time of maneuvering from extreme depression to extreme elevation, or the reverse, not to exceed fifteen seconds, and the time of complete traversing not to exceed two minutes: *Provided*, That in case the first-named time is not attained, a forfeiture of twenty-five dollars shall be imposed for each additional second of time required in excess of the time stated: *And provided further*, That the limit of excess in time to be allowed for elevating (or depressing) shall be twenty seconds.

The time of maneuvering by electric power by extreme depression to extreme elevation, and the reverse, varied between 9 seconds and 13 seconds in the different guns. The time required for traversing through 360 degrees by power varied between 41 seconds and 1 minute 38 seconds. By hand, gun No. 3 was traversed by nine men, spelled by four others, in 11 minutes 12 seconds, and elevated from 0 to 35 degrees in 47 seconds and back in 44 seconds. This gun was the most difficult of the three to traverse.

SPECIFICATION 16.

The time required for discharging twenty consecutive rounds with the heaviest charges from any single gun must not exceed one hour and twenty minutes, and that required for discharging thirty consecutive rounds must not exceed two hours and ten minutes.

There were not on hand sufficient projectiles to carry out this test. As 5 of the heaviest projectiles were discharged in 8 minutes 23 seconds, it is more than probable that 20 could be discharged within the hour.

SPECIFICATION 17.

All dimensions to be subject to such slight changes, not materially affecting the results to be attained, as the United States may agree to make as the work progresses.

No information of any changes in dimensions was received by the Board.

SPECIFICATION 18.

All materials and workmanship are to be of good quality, the valves and joints to be air-tight under working pressures, and all parts of the guns and machinery to be efficient in operation. The work shall be open to inspection by the Government at all stages.

This specification has been fully complied with.

CONCLUSIONS.

The Board therefore concludes that the guns, carriages, appliances, etc., forming the pneumatic dynamite-gun battery and plant at the Presidio of San Francisco, Cal., fulfill all the requirements specified in the contract dated January 27, 1893, between the United States and the Pneumatic Torpedo and Construction Company.

For the purposes of the test a temporary water supply was provided by the contractors. The plant, consisting of pump, boilers, supply pipes, and storage tank, will, it is believed, be removed by them. This leaves the battery without any water supply, without which it can not be operated, and without which, indeed, the proper care for its preservation can not be exercised.

A full set of drawings of the guns, carriages, projectiles, etc., has been turned over by the contractors.

A full set of drawings of the compressor plant will be furnished by the builders, the Fulton Engineering and Shipbuilding Works.

L. S. BABBITT,
Lieutenant-Colonel, Ordnance Department, U. S. A., President.
W. H. HEUER,
Major, Corps of Engineers, U. S. A.
ORMAND M. LISSAK,
Lieutenant, Ordnance Department, U. S. A.

SUMMARY OF TESTS.

Tests for capacity of compressors, specification 3, December 4, 1895.

45-ROUND TEST, USING 3 GUNS; AIR SHOTS.

Gun No. 1.				Gun No. 2.				Gun No. 3.			
No. of round.	Time.	Valve setting.	Loss of pressure.	No. of round.	Time.	Valve setting.	Loss of pressure.	No. of round.	Time.	Valve setting.	Loss of pressure.
	Min.		*Pounds.*		*Min.*		*Pounds.*		*Min.*		*Pounds.*
1	0	270	59	2	1½	470	76	3	3	400	69
4	4½	270	62	5	6	470	74	6	7½	400	63
7	9	280	68	8	10½	475	76	9	12	410	73
10	13½	290	75	11	15	475	75	12	16½	415	81
13	18	290	75	14	19½	480	75	15	21	415	82
16	22½	290	75	17	24	480	75	18	25½	415	80
19	27	295	78	20	28½	485	76	21	30	415	90
22	31½	300	83	23	33	490	81	24	34½	415	93
25	36	300	83	26	37	490	84	27	38	415	94
28	39	300	84	29	40	490	83	30	41	415	94
31	42	300	84	32	43½	490	84	33	44½	415	95
34	46	300	84	35	47	490	85	36	48	415	95
37	49	300	85	38	50	490	86	39	51	415	94
40	52	300	84	41	53	490	86	42	54	415	94
43	55	300	85	44	56	490	86	45	57	415	97
46	58	300	85	47	59	490	86	48	60	415	96
49	61	300	85	50	62	490	87	51	63	415	95
52	64	300	85	53	65	490	87	54	66	415	98

NOTE.—The time, in minutes, is taken from the firing of the first round. The first nine shots were thrown out on account of insufficient loss of pressure.

Tests for capacity of compressors, specification 3, December 4, 1895—Continued.

20-ROUND TEST, USING 1 GUN; AIR SHOTS.

[Gun No. 1. Time of 20 rounds, 7 minutes 30 seconds. Valve setting, 300.]

No. of round.	Loss of pressure	No. of round.	Loss of pressure.	No. of round.	Loss of pressure.	No. of round.	Loss of pressure.
	Pounds.		*Pounds.*		*Pounds.*		*Pounds.*
1	85	6	87	11	87	16	89
2	86	7	88	12	88	17	87
3	84	8	86	13	87	18	89
4	86	9	87	14	90	19	89
5	86	10	89	15	86	20	89

Tests for time of maneuvering in azimuth and elevation, specification 15, December 4, 1895.

MANEUVERING WITH ELECTRIC POWER.

	Gun No. 1.	Gun No. 2.	Gun No. 3.
	′ ″	′ ″	′ ′
Traversing to the right 360 degrees	0 54½	0 41	1 23
Traversing to the left 360 degrees	1 9	1 4	1 38
Elevation 35 to 0 degrees	0 13	0 11	0 11½
Elevation 0 to 35 degrees	0 9	0 11	0 11½

MANEUVERS BY HAND GUN NO. 3.

Traversed to the right 360 degrees by 9 men, spelled by 4 others, 11 minutes 12 seconds.

Elevation 0 to 35 degrees, 8 men, 47 seconds.

Elevation 35 to 0 degrees, 8 men, 44 seconds.

Tests for rapidity of loading and firing, specification 14, December 5, 1895.

The guns were loaded at 7 degrees and fired at 30 degrees elevation. Dummy projectiles filled with sand and weighing about 1,130 pounds were used.

Gun No. 3, five rounds in 9 minutes 20 seconds.

Gun No. 2, five rounds in 10 minutes.

Gun No. 1, five rounds in 8 minutes 23 seconds.

Special effort for rapidity was made only in the rounds fired from gun No. 1.

No. of round.	Gun No. 3.			Gun No. 2.			Gun No. 1.		
	Time.	Valve setting.	Loss of pressure.	Time.	Valve setting.	Loss of pressure.	Time.	Valve setting.	Loss of pressure.
	′ ″		*Pounds.*	′ ″		*Pounds.*	′ ″		*Pounds.*
1.....	1 0	415	116	0 50	490	98	0 45	300	86
2.....	3 0	415	119	2 50	490	99	2 43	300	96
3.....	4 55	415	118	5 10	490	98	4 27	300	99
4.....	7 20	415	119	8 00	490	99	6 27	300	97
5.....	9 20	415	119	10 00	490	99	8 23	300	97

The time for beginning to load is taken as 0.

Tests for range and action of fuse, specifications 11 and 6, December 5, 1895.

[8-inch subcaliber shell.]

Gun.	Shell.	Weight in gun.	Weight in flight.	Elevation.	Valve setting.	Loss of pressure.	Fuse setting.	Range.	Time of flight.
		Pounds.	*Pounds.*	°		*Pounds.*	*Secs.*	*Yards.*	*Secs.*
No. 2.....	Weighted.	376¾	332¾	23	475	160	....	....	....
	Live.......	376½	334⅛	20	475	160	Inst.	....	....
No. 3.....	Weighted.	377	333	35	475	142	....	4,830	27⅛
	Live.......	372¾	331½	35	475	146	2	4,685	....
No. 1.....	Weighted.	377	333	15	0	24	....	1,585	10¾
	Live.......	373	332	15	0	26	2	1,630	11

Remarks.—The live shell contained 100 pounds of explosive.

The rounds from gun No. 2 were fired into the hill across the harbor at a range of about 3,700 yards. The others were fired into the sea.

The differences of weights in gun and in flight are the weights of the gas checks and runners which leave the projectile soon after its issuance from the gun. The fuses acted according to their adjustment. In the fourth and fifth rounds of the table the projectiles were slightly unsteady in the first part of the flight. In every other case the flight of the projectile was excellent.

Test for accuracy, specification 12, December 9, 1895.

[8-inch subcaliber shell, 100 pounds explosive, gun No. 3, elevation 35°, valve setting 385.]

No. of round.	Weight in gun.	Weight in flight.	Loss of pressure.	Range.	Time of flight.
	Pounds.	*Pounds.*	*Pounds.*	*Yards.*	*Seconds.*
1.....	378¼	334¾	88	5,000	26⅞
2.....	378⅛	335	89	5,070	27⅛
3.....	377¾	334¾	93	5,015	27⅛
4.....	378¼	334¼	92	5,040	27⅜

Remarks.—The fuses were set for instantaneous action and exploded on impact. The flight of each projectile was excellent. The wind was blowing about 15 miles an hour from the direction of 5 o'clock.

TARGET.

[The line of fire is taken as the line from gun through center of impact of shots.]

Range.		Deviation.	
Beyond.	Short.	Right.	Left.
....	31.25	32	....
38.75	....	....	2
....	16.25	....	10
8.75	....	....	20

	Yards.
Range of center of impact	5,031¼
Mean dispersion in range	23¾
Extreme dispersion in range	70
Mean lateral dispersion	16
Extreme lateral dispersion	52

The rounds below were also fired from gun No. 3 on this day:

Shell.	Weight in gun.	Weight in flight.	Elevation.	Valve setting.	Loss of pressure.	Time of flight.	Range.
	Pounds.	*Pounds.*	°		*Pounds.*	*Seconds.*	*Yards.*
Weighted....	383⅜	335	35	385	93	25⅛	4,410
Live.........	372⅞	334	20	400	99	16⅜	3,700

Remarks.—The projectiles were 8-inch subcaliber shell, the live one containing 100 pounds of explosive. The weighted shell was fired to sea, the live one into the hillside, with a fuse set for impact. The flight of both shells was excellent.

Proof test with heaviest projectiles.

[Full caliber shells, charged with 500 pounds explosive.]

Gun.	Weight in gun.	Weight in flight.	Elevation.	Valve setting.	Loss of pressure.	Range.	Time of flight.
	Pounds.	*Pounds.*	°		*Pounds.*	*Yards.*	*Seconds.*
No. 3	1,145¾	1,104	35	360	72	1,950	18
No. 2	1,147¾	1,107¾	35	530	110	2,170	18⅓
No. 1	1,152¼	1,108¼	35	300	80	2,080	18⅓

REMARKS.—Fuses were set for half a second delay. All exploded. The shells in flight were very unsteady. The tail of each projectile described a wide circle about the trajectory, the head meanwhile describing a smaller one. The projectiles did not deviate remarkably from the direction of fire.

APPENDIX A.

DIRECTIONS FOR THE CARE OF PNEUMATIC GUNS AND AIR-COMPRESSING PLANTS.

When the air-compressing machinery is not to be used for considerable length of time, the following directions should be observed:

Boilers.—Empty the boilers and clean them thoroughly. Remove manhole and hand-hole covers. Dry out the boilers with a slow wood fire. Raise the safety valves off their seats and block them up. Drain all feed, steam, and blow-off pipes.

Feed pumps.—Drain the cylinders, steam chests, and all pipes. Remove all packing from stuffing boxes. Remove cylinder heads and steam-chest covers. Clean all parts inside and outside. Cover all bright parts with a coat of heavy grease or a mixture of white lead and tallow.

Air compressors and engines.—Remove cylinder heads and steam-chest covers from both steam and air cylinders. Remove all packing from stuffing boxes. Clean the engines inside and outside. Coat all bright parts with heavy grease or with a mixture of white lead and tallow. Cloth covers should be placed over each machine. Drain the jackets of the air cylinders. Drain all water-circulating pipes, steam pipes, and air pipes. Drain the intercoolers or cooling tanks and clean the tanks. If air is left in the storage reservoir the blow-off valves on the distributing manifolds should be open.

Fifteen-inch seacoast guns.—Place the guns in horizontal position. Remove pistons from auxiliary valves and coat them with heavy grease. Remove from the gun and carriage the gauges, discharging lever, clutch lever, rheostat handwheel, and all finished rods, levers, etc., that connect with the auxiliary; coat them with grease and lay them in a dry place. Coat all bright or finished parts of the gun with heavy grease or a mixture of white lead and tallow. Canvas covers should be placed over the carriage and the entire portion of the guns in rear of trunnions. Place canvas covers over the muzzles. If the gun is to stand unused for more than a year, the main valves should be removed from the breech, coated with grease and removed to a dry place. For a shorter time than this the oil in the packings and interior of gun will protect the main valves and they need not be removed from the gun.

If the guns and machinery are to be kept ready for use at a day's notice the following instructions should be observed:

Keep the engines, boilers, pumps, etc., ready for use at all times. As the machinery is in duplicate, one-half of the plant can be kept in readiness to run while repairs are being made upon the other half when this is necessary.

Move the engines and pumps a little by hand every day to prevent the pistons and piston rods from rusting.

Get up steam in one of the boilers once a week and run the air compressors, engines, dynamos, etc., for half an hour. Use the boilers alternately.

Keep the storage reservoir filled with air to 2,000 pounds per square inch. Drain all water from the storage reservoirs after filling them.

Fill the gun reservoir with air to 1,000 pounds per square inch once in two weeks, and discharge six air shots from each gun.

Keep all bright finished parts of the guns coated with heavy grease to prevent rusting.

Before discharging the guns drain all water and oil from the breech and the firing reservoir underground.

NOTE.—The preceding instructions, prepared at the request of the Chief of Ordnance, United States Army, were received at this office from Mr. B. C. Batcheller, engineer of the Pneumatic Torpedo and Construction Company.—*Office of the Chief of Ordnance, U. S. A., Washington, January 15, 1896.*

(2886—Enc. 124)

APPENDIX 33.

DESCRIPTION OF LEWIS RANGE AND POSITION FINDER.

(6 plates.)

OFFICE OF THE CHIEF OF ORDNANCE, U. S. A.,
Washington, May 26, 1896.

DESCRIPTION.

The accompanying photographs show the latest service model of this instrument.

The principal parts are all numbered on the plates, the same notation being observed throughout, but may be most distinctly seen on Pls. I, II, and III, as follows:

PLATE I.

1. Hollow cast-iron column.
2. Leveling screws for column.
3. Table, cast-iron, 60 inches diameter.
4. Table edge for friction rollers.
5. Projections from under side of table, necessary for casting and used for securing fine adjustment of level.
6. Traversing arm which supports and carries all parts of the mechanism.
7. Center about which arm turns, 18 inches long, and extending down through table and column. *7a.* Female center secured to table.
8. Top nut and washer of male center which secures it to the arm.
9. Eye piece of telescope.
10. Object glass of telescope.
11. Metal frame or cradle which supports telescope.
12. Horizontal axis about which telescope moves.
13. Micrometer attachment to correct for abnormal refraction.
14. Screw to adjust focus.
15. Hollow brass pillar which contains counterweights.
16. Rollers over which cord passes.
17. Cords for counterweights.
18. Steel pin supporting frame that carries telescope.
19. Adjustable top to elevating cylinder, having small roller on which pin 18 rests.
20. Elevating cylinder moving in guides and carrying rack.

PLATE II.

21. Bracket which supports the elevating screw.
22. Vertical elevating screw, 1 inch diameter, 8 threads per inch.
23. Arm of elevating sector.
24. Bracket supporting pivot of sector.
25. Double bracket supporting and guiding elevating cylinder.
26. Rack on elevating cylinder into which meshes the toothed arc of the elevating sector.
27. Elevating sector.
28. Horizontal screw which moves pivot 31 along scale 29.
29. Altitude scale in feet, showing length of vertical base line.
30. Brass plate secured to the nut of elevating screw which forms support for scale 29 and screw 28.
31. Movable pivot which operates the elevation and depression of telescope.
32. Crank which operates the elevating mechanism.

33. Milled head of hard rubber for convenience when moving slowly.
34. Beveled gears.
35. Crank which turns the traversing arm (6) in azimuth.
36. Friction roller moving on edge of table.
37. Azimuth device.
38. Index reading degrees.
39. Index reading minutes.

PLATE I—continued.

40, 40*a*. Plotting attachment.
41. Sliding pointer. A double scale is provided, to be read from either side.
42. Range wheel (see also Pl. IV).
43. Case protecting range wheel.
44. Rollers attached to traversing arm (6), moving on top of table.

PLATE III.

45. Level. Bubble moves 0.25 inch for 1 minute.
46. Vertical spindle with worm which operates azimuth device.
47. Gearing on spindle which operates minute dial.

The essential parts are as follows:

First. *A hollow cast-iron column* resting upon three feet, the feet being provided with capstan-headed brass leveling screws (1, 2, 2, Pl. I).

To the top of this column is bolted the cast-iron table. The column should rest upon a solid foundation, preferably of masonry. No especial precaution need be observed in setting up the column and securing the table thereto, except to see that the lag screws are in their proper places and screwed up firmly.

Second. *A circular cast-iron table*, 60 inches in diameter, turned perfectly true on the outer edge, and concentric therewith is turned at the center the seat for the female center (3, 4, 5, and 7*a*).

This table is a solid casting strengthened by deep, tapering, radial ribs. The top is turned, ground, and polished, as is the outer edge, on which rolls the friction rollers of the azimuth measuring device and the crank device which moves the telescope in azimuth. The female center (7*a*) projects downward through the table and column for a distance of 18 inches, its top flange being turned to fit the annular groove turned from the table center. The female center is a composition casting and is secured to the table by bevel-headed screws.

The projecting lugs (5, 5, etc.), six in number, are a necessity in casting the large table, and are also useful in securing and leveling the table on the lathe before turning. They are left on the completed instrument to be used as auxiliary supports in order to secure a very fine adjustment of level for the table, but are not intended to support the weight of the instrument. To utilize them as auxiliary supports six small columns (preferably 4-inch iron pipe filled with concrete) should project upward from the foundation base to within 2 inches of the lower face of these lugs. Small leveling screws may be provided to engage in the lower extremity of the lug and rest upon iron caps on the 4-inch columns.

Third. *A cast-iron traversing arm* (6) which carries all the other parts of the instrument. This arm is pivoted at the center of the table (male center 7 and 8), and is moved in azimuth by a friction-roller device (36 and 35, Pl. II) operating on the outer edge of the table. In front the arm curves upward, so as to clear the surface of the table, and furnishes a support for the horizontal axis of the telescope, and it also supports the plotting attachment (40*a*, 40, and 41, Pls. I and V).

The traversing arm is a single casting, having two side ribs for stiffness, a solid core through which passes the male center, and a wide, flat, end surface, planed perfectly true, for the various parts of the elevating mechanism to rest upon.

Fourth. *The telescope and its cradle* (9, 10, 11, 12, and 13).

The telescope has a 3-inch object glass, 40-inch focal length, 25 magnifying power, and a micrometer attachment (13) which moves the horizontal cross wire and thus affords an easy correction for abnormal refraction (each division of scale on the micrometer head corresponds to a movement of one-ten-thousandth of an inch).

The eyepiece is easily moved and may be pushed in or out by turning it slightly with the hand. The colored shades should only be used when necessary to protect the eye of the observer.

As the range scale in construction is already corrected for the effect of normal refraction (one-seventh effect of curvature), the micrometer (13) is to be used only when the effect of refraction is abnormal. To make the necessary correction, direct the telescope upon an object whose range is known; turn the crank (32) until the proper range is read from the range scale; then look through the telescope and see if the horizontal wire coincides with the water line of the object. If so, no correction is necessary; if not, turn the micrometer screw until they do coincide. Under ordinary conditions of the atmosphere, it is seldom necessary to make correction for refraction.

As shown in the photographs, the telescope turns about a horizontal axis (12) in front of the object glass, and all angular movements of the telescope are produced by raising or lowering the eye end at the point where pin (18) rests upon the top (19) of the elevating cylinder (20) called the "point of tangency." The horizontal distance between the axis (12) and this point is exactly 60 inches. Since by construction the elevating cylinder (20) can move only in a vertical direction, the point of tangency describes a right line which is the natural tangent of the angle through which the telescope is moved, the radius being 60 inches.

Fifth. *The elevating mechanism*, which consists of the following parts, viz: Elevating screw (22); nut moving thereon; crank (33), and handle (32) which turns the screw by means of the bevel gearing (34); toothed sector (27) and sector arm (23); pivot (31) which is carried transversely along the altitude scale (29) by the small horizontal screw (28); the bracket support for screw (21); bracket support for sector (24); elevating cylinder (20); brackets supporting same (25); toothed rack on cylinder (26); adjustable head to cylinder (19).

Sixth. *The counterweights.* These are contained in two brass columns (15, 15). The weights are suspended from cords (17, 17) which pass over pulleys (16, 16) down through the center of the screw caps on the pillars. These pillars are secured to the top surface of the traversing arm by screws.

Seventh. *The range wheel*, shown in Plate IV, and as No. 42 in Pls. I and V. This wheel is 12½ inches in diameter, the gear cut in its circumference being 48 pitch and having 600 teeth. The wheel is mounted on the flat under surface of the traversing arm. The graduation is in black on white celluloid, which is one-sixteenth of an inch thick and set into the metal. The figures show hundreds of yards of range. The scale reads directly to 10 yards, from 1,500 to 6,000 yards, and to 25 yards from 6,000 to 15,000 yards.

A small pinion is carried on the under projection of large elevating screw and meshes with the gear of the range wheel. A cover (43) is fitted over the wheel to protect against dust and accident; the opening in this cover (42) has an index for reading the scale. The gears are very carefully mounted to avoid back lash.

Eighth. *The azimuth device* (37) is shown very fully in the photographs. Degrees are read from the vertical index (38) and minutes are read from the horizontal index (39). Pl. III shows the gearing (47) and vertical worm shaft of this device. A friction roller carried on the vertical shaft rolls on the outer edge of the table, each complete revolution corresponding to 9 degrees of azimuth. Means are provided on the friction roller for moving the shaft and the recording mechanism independently of the roller itself. This enables the operator to quickly correct and set the mechanism to any desired reading without moving the telescope in azimuth.

Ninth. *Means for moving the telescope and arm in azimuth.* This is done by means of a crank (35) which operates a friction roller mounted on the under flat surface of the arm and which rolls around the outer edge of the table. The photographs do not show these parts in detail, but their simplicity is such that no further description is needed.

Tenth. *Spirit level* (45). This is shown in Pl. III, and is used to adjust the level of the table. When in perfect adjustment the arm may be traversed through an entire circle (360 degrees) without changing position of bubble.

PRECAUTIONS TO BE OBSERVED IN SETTING UP THE INSTRUMENT.

Put column in place over the center of the foundation pier, and see that the leveling screws project through the feet about 1 inch and rest in the cast-iron cups.

The table is then lifted and placed on top of the column and the lag screws put in and firmly screwed in place. Both centers should be carefully examined, cleaned, and oiled, and the adjusting nut on the bottom should be turned until the weight of the male center rests entirely on the bottom, while the side and top surfaces should remain in contact. When the centers are adjusted the traversing arm with all the parts assembled upon it is lifted into place, the shank of the male center passing through the hole in the hub and then secured by the nut and washer on top.

All parts carried on the arm are shipped in place, and it will only be necessary to see that all are clean, a little good oil dropped on the wearing surfaces, and that all the parts move freely without binding.

The next step is to carefully level the table by means of the three leveling screws in the feet, and finally in getting a very perfect level the six small leveling screws in the projecting lugs are used, but it should be remembered that these latter are not intended to support the weight of the table, and should only be brought into use to counteract the effect of flexure in the metal.

When the leveling is properly done it will be possible to move the arm an entire revolution without displacing the bubble.

As soon as the table is level, see that all parts of the elevating mechanism are in good working order. The parts should work smoothly and easily without the slightest sound. See that the counterweights are put in place and properly adjusted, and do not strike the bottom of the pillars before the telescope is elevated to its highest position (this will be when the range mechanism indicates the shortest range on the scale and the sector arm is horizontal).

The top (19) of the elevating cylinder should next be adjusted. To do this, direct the telescope upon some object having a water line, whose exact range is known. Set the range mechanism by turning crank (32) until the index reads the known range. Look through the telescope and see if the horizontal cross wire coincides with the image of the water line. If so, the adjustment is correct and should never again be changed as long as the instrument remains on that site. If not, raise the eye end of the telescope with the hand until the pin (18) is clear of its roller in (19). The top (19) can then be screwed in, or out, according as the wire was below or above the water-line image, until exact coincidence is obtained. A slight movement of the horizontal cross wire may also be made by turning the micrometer head (13), but care should be taken in doing this that the wire be not displaced too far from the middle of the field.

The bracket which supports the large friction roller underneath the arm must be screwed very firmly in place by means of the three large screws which extend entirely through the arm from the top surface. This will give all the friction necessary to operate the crank mechanism and to turn the arm about its center. If at any time during the use of the range finder this roller should begin to slip, tighten these three screws at once.

The azimuthing device, or "direction indicator," is complete in itself and will be found mounted in place on the arm. It is secured to the arm by four brass screws with copper washers from the under side. These screws should be all loosened and the device then pushed forward until its friction roller is pressed against the outer edge of the table sufficiently hard to operate the mechanism. No great amount of pressure will be needed. In first setting the azimuth reading, direct the telescope upon some distant object whose exact azimuth has been determined in advance. Before pressing the friction wheel against the edge of the table turn the spur wheel on the main vertical shaft until the proper reading is shown on both the degree dial and the minute dial. Pressure is then applied and the four screws are tightened. The telescope should now be turned off the object and then be brought back to it again. If the reading is not correct, make the small necessary correction by turning with a screw-driver the small tangent screw carried on the under side of the friction roller. This tangent screw is mounted so that the movement of the screw turns the vertical shaft and hence the mechanism, without turning the friction wheel. This will be found a very convenient means of correcting the reading at any time and should be frequently applied in actual service.

The horizontal scale carried on the elevating nut is called the "altitude scale" and indicates the exact height (in feet) of the horizontal axis of the telescope above the surface of the water. As this distance is by construction the working base of the instrument, and since it is increased and decreased by the fall and rise of the tide, a tide gauge which shows the height of the tide in feet above or below mean low tide will be necessary for the correct use of the range finder. When first set up the height of the axis of the telescope above mean low tide is very accurately determined by measurement. A table is then prepared and posted near the instrument showing the exact length of the working base for each reading of the tide gauge, so that the operator as soon as he knows the tide reading will know at a glance the correct reading along the altitude scale at which to set the index of the elevating pivot (31). This may be quickly done by turning the micrometer screw (28). It will be found in actual practice that this correction will not have to be made oftener than once an hour unless the tidal changes are very considerable, but since the correction can be made in a moment, it is well to read the tide gauge frequently.

The micrometer (13) is for the purpose of making correction for abnormal refraction. It operates to move the horizontal cross-wire of the telescope vertically. Its use will only be found necessary under certain atmospheric conditions which produce the physical phenomenon called mirage. Direct the telescope upon an object whose exact range is known and set the range index to read that range. If the horizontal cross-wire coincides with the water line of the object no correction is necessary; if not, the micrometer is turned until there is coincidence. Be careful to see that the level of the table is still preserved before making this correction.

The instrument should be protected from moisture and dust when not in use, and it is advisable to keep it covered with a rubber cloth or oilcloth. The parts should be oiled occasionally and kept free from dust. All steel parts will be found to be polished or nickel plated except the large elevating screw, and this should be kept thoroughly oiled. The table top should also be kept free from rust by the frequent use of vaseline.

All parts of the instrument are strong and well made and none are likely to get out of order, but care should be exercised in using it, however, since the accuracy of the results obtained will depend largely upon whether or not all parts are kept in good working order.

Only officers, or intelligent noncommissioned officers, should be permitted to use the instrument.

INSTRUCTIONS FOR OPERATING THE INSTRUMENT.

It is assumed that a tide gauge, to show the height of the tide in feet above or below mean low tide, has been placed in a position to be readily seen by the observer at the instrument; that one or more datum points have been established whose exact distance and azimuth from the instrument are known; and that the instrument has been set up according to the instructions given herewith.

Before attempting to get the direction and distance of an object, the observer should first see that the table is level; if it is not, he should make it so by means of the three screws (1, 2, 2) in the feet of the instrument, and also by the six small leveling screws in the projecting lugs (5), if such are in use. If the table is level, the arm (6) can complete an entire revolution without displacing the bubble of level (45).

The necessary correction for tide is next made; this is done by reading the tide gauge and making the exact length of vertical base correspond to this condition of tide. To do this, set the index of the elevating pivot (31), by means of the micrometer screw (28), so that the altitude scale (29) will give the exact working base, or distance of the instrument above the water level. This correction should be made at least every hour, oftener if great accuracy is desired.

Under certain atmospheric conditions there will be abnormal refraction; to ascertain if there be such, and to correct for it, first set the range scale (42) to read the distance to an object whose exact range is known. Turn the instrument on the object, and if the horizontal wire does not coincide with the water line of the object, turn the micrometer screw (13) very slightly until it does.

The instrument should be now ready for use. To get the azimuth and range of an object, with the left hand turn the crank (35) to bring the vertical wire of the instrument on the desired point of the object—the indices (38 and 39) will give the corresponding degrees and minutes of azimuth—at the same time move the crank (32) with the right hand until the horizontal cross-wire cuts the object on the water level; the range can then be read at once from the scale (42).

NOTE.—The instructions given herewith for operating the instrument relate, as will be seen, to its use for its own position only, and do not include the methods of communicating the information obtained with the instrument to a gun or battery situated at a distant point or the means of determining the position of the target with reference to a gun so situated.

(4613) D. W. FLAGLER,
Brigadier-General, Chief of Ordnance.

THE LEWIS REPLOTTER.

(Plate VI.)

NEW YORK ARSENAL,
GOVERNORS ISLAND, NEW YORK HARBOR,
New York City, April 5, 1897.

SIR: I have the honor to forward herewith a photograph and description of the Lewis replotter, which can be used in connection with the Lewis position finder.

Very respectfully,

FRANK H. PHIPPS,
Major, Ordnance Department, U. S. A., Commanding.

The CHIEF OF ORDNANCE, U. S. Army,
Washington, D. C.

DESCRIPTION.

This device is designed for use with the service-type Lewis position finders for the purpose of quickly converting ranges and azimuths as measured from the position finder into the corresponding ranges and azimuth of the same target measured from the gun itself.

The accompanying photograph shows the position finder at Fort Wadsworth with the replotter in position on its table.

There are three essential parts to the replotter:

(1) A brass arc, which is really a segment of a gear wheel inlaid into the face of the outer rim of which is an arc of celluloid graduated into degrees and numbered to show true azimuths.

(2) A scale-bearing arm graduated and numbered so as to read directly to tens of yards, pivoted at the center of the arc.

(3) A small minute dial with its necessary mechanism carried on the arm so that its small motor pinion is at all times in mesh with the teeth of the main arc. The dial is only 2 inches in diameter and is graduated and numbered into minutes. A small pointer actuated by the pinion as the scale arm is moved about its center enables the operator to read minutes of azimuth at a glance and without the aid of a vernier. Degrees of azimuth are read directly from the large arc scale.

The scale on the arm of the replotter must of course be the same as that of the scale arm of the position finder.

The "center" of the replotter corresponds to the position of the gun or to the center gun of a group of guns. The size of the main arc will be determined by the field of fire of the gun or group. Ordinarily the field of fire will not exceed 120°, but in certain special cases it may be 360°, or all around fire, in which case the replotter arc is a complete circle.

The device is very simple, the parts are few and strong, and there is nothing to get out of adjustment or out of order with ordinary care. It can be removed from the table of the position finder and replaced in position in a moment and a number of different guns or groups can be permanently located on the table of the position finder.

By referring to the photograph, the use of the replotter will be apparent at a glance.

One operator in addition to the observer at the telescope of the position finder is needed.

The operation is as follows:

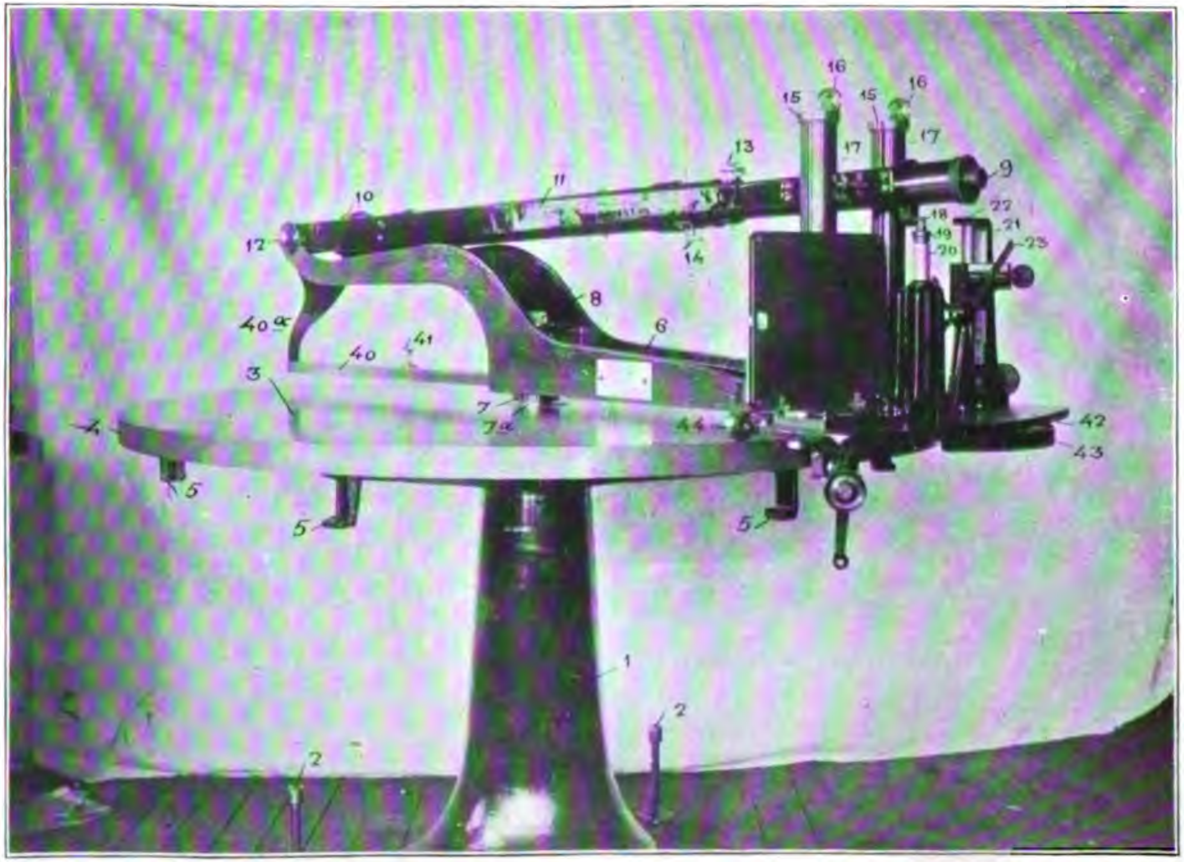
The observer at the telescope follows the moving object. At the given signal he stops and calls out the range, as shown on the range dial. He does not call out the azimuth, since that is already indicated by the position of the range-scale arm projecting over the table in front.

The operator at the replotter, as soon as he hears the range, moves the sliding pointer along the scale arm of the position finder to the proper range and then quickly brings the replotter arm into contact with it. He then reads the range from the gun to the object directly from the scale of the replotter and the correct azimuth from the gun is also directly read.

With this device it is possible to correctly replot the position of a moving target with respect to the gun at intervals of ten seconds of time without hurry or confusion.

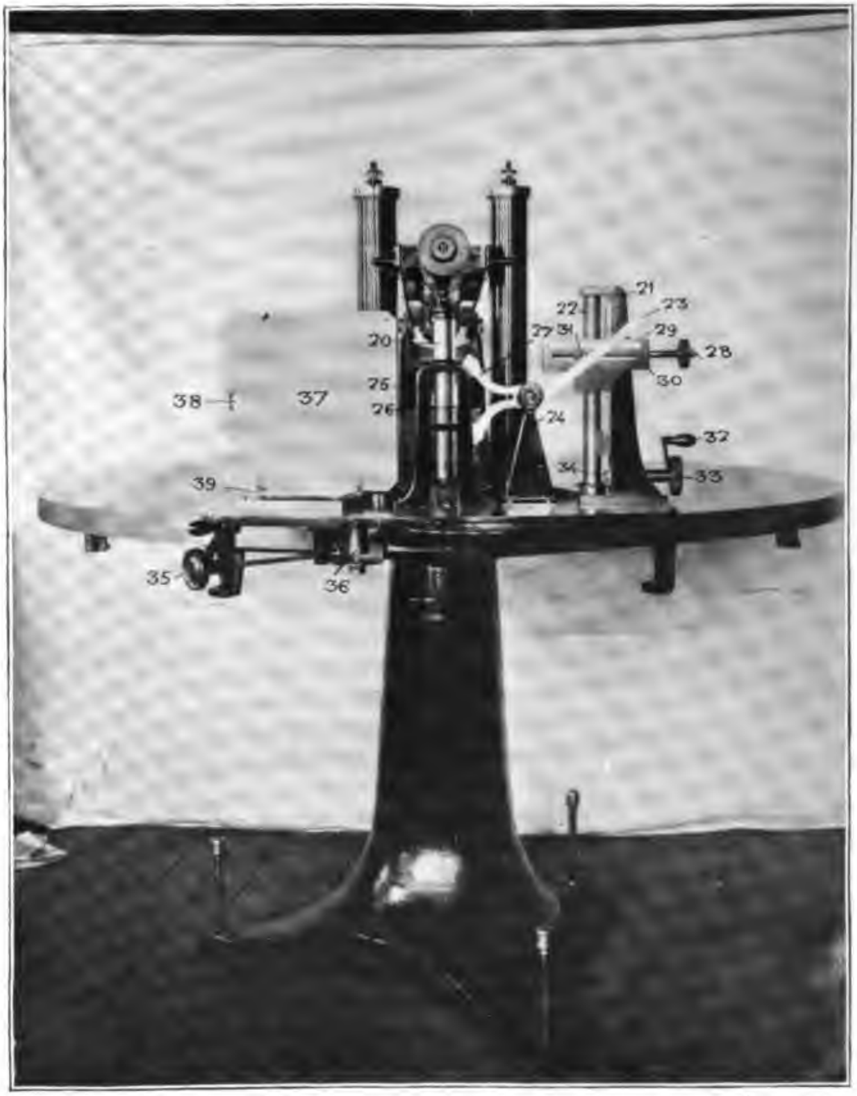
Only one extra man is required in the position-finding station, and the information which is actually used at the gun in laying is received directly from the position-finding station by telephone or telegraph.

(4613—Enc. 94)



LEWIS RANGE FINDER. SIDE AND END VIEW FROM THE FRONT.

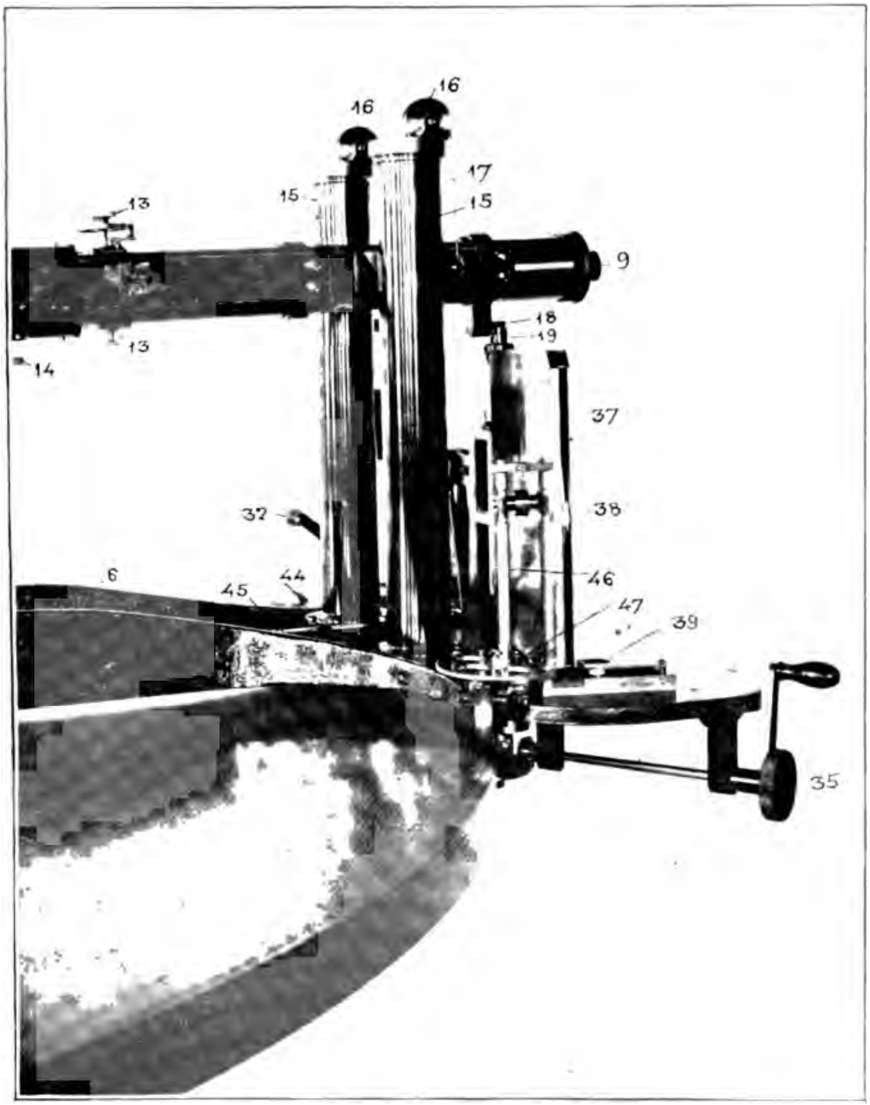
PLATE II.



Appendix 33, 1896.

LEWIS RANGE FINDER. END VIEW.

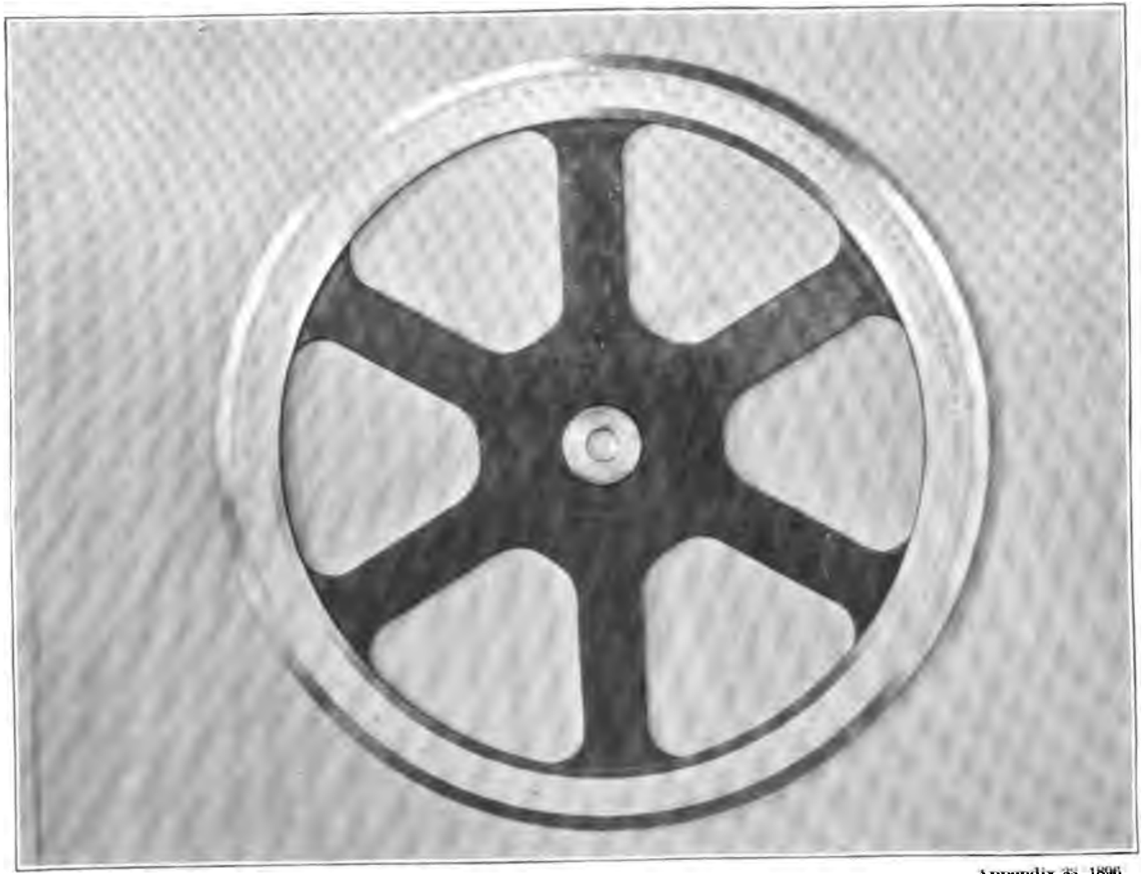
PLATE III.



Appendix 38, 1896.

LEWIS RANGE FINDER. PARTIAL SIDE VIEW.

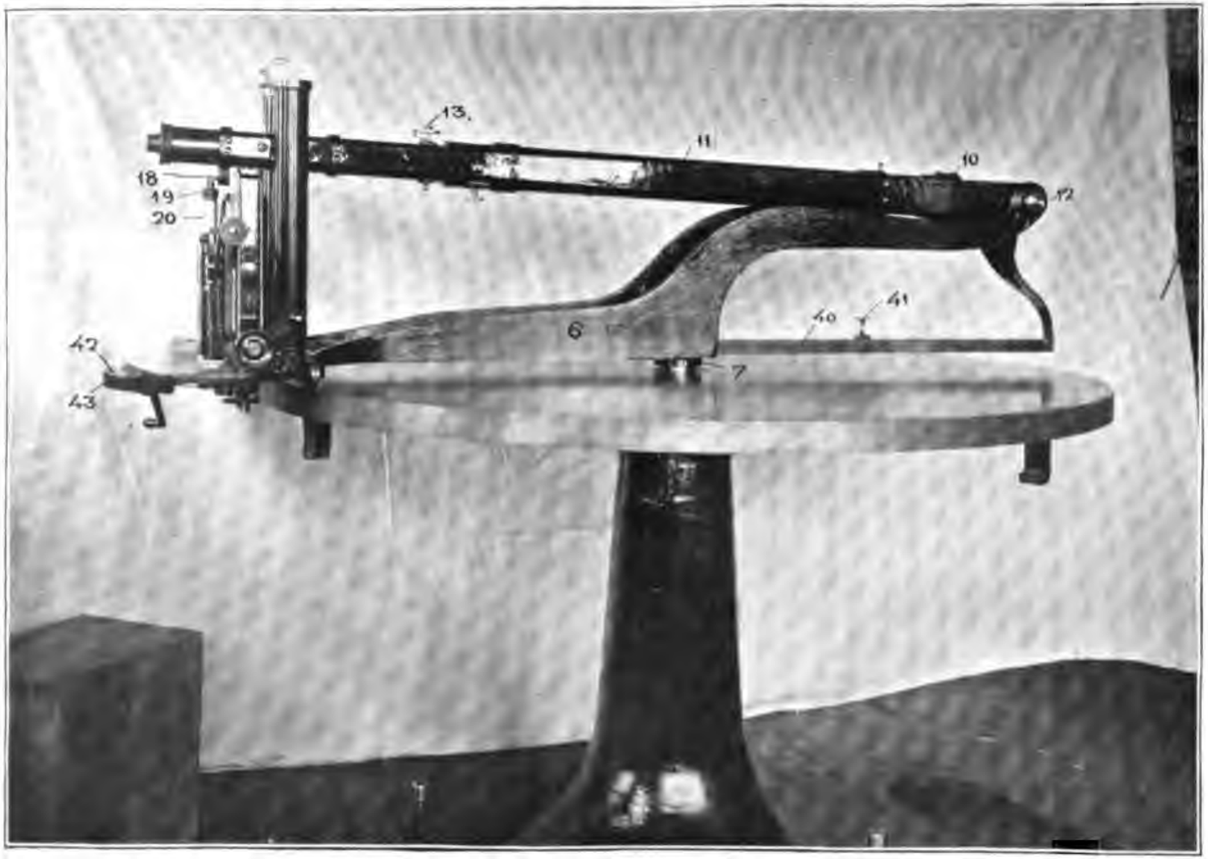
PLATE IV.



Appendix 35, 1896.

LEWIS RANGE FINDER. RANGE WHEEL.

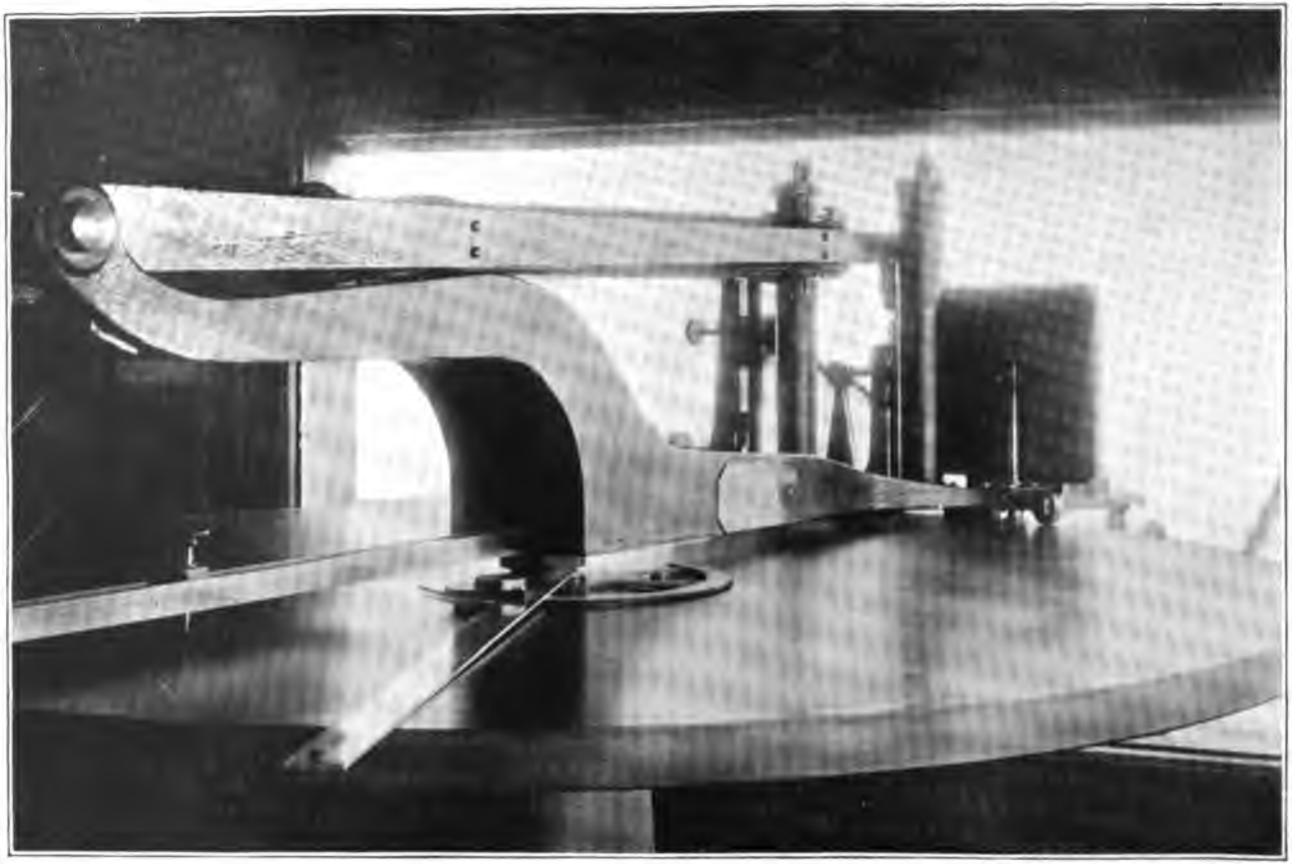
PLATE V.



LEWIS RANGE FINDER. SIDE VIEW.

Appendix 33, 1896.

PLATE VI.



Appendix 33, 1896.

LEWIS RANGE AND POSITION FINDER WITH REPLOTTER IN POSITION.

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